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USSR REPORT

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ELECTRIC POWER

MORE EFFICIENT MANAGEMENT OF ENERGY SECTOR URGED

Moscow PARTIYNAYA ZHIZN' in Russian No 1, Jan 80 pp 15-23

[Article by V. I. Dolgikh, secretary of the CPSU Central Committee: "To Raise the Management Level of Enterprises in the Fuel and Energy Complex"]

[Text] In carrying out the plans of the 25th Party Congress, the Soviet people are working intensely on achieving the quotas of the Tenth Five-Year Plan and are constantly increasing the economic potential of our motherland.

Every 10 years the production volume in the nation virtually doubles. The strengthening of the economy is a decisive contribution to the cause of the struggle for peace in the world and to raising the prosperity of the people as the main aim of the CPSU.

One of the key conditions for ensuring high economic growth rates is the more rapid development of the fuel and raw material base, and a rise in the level of mechanization and the use of power in the national economy. In the present-day world, the level of all types of energy production and consumption also determines the economic development level of a society.

The Communist Party and its Central Committee have always given and are giving primary significance to developing the sectors of the fuel and energy complex as the basis of the entire national economy and as an indispensable condition for scientific and technical progress. In each stage of communist construction, power engineering has been confronted with particular tasks, but they have always been among the most urgent and fundamental.

Of decisive significance for the development of the nation's fuel and energy complex are the decisions of the 23d, 24th and 25th CPSU congresses which marked the beginning to the accelerated development of the oil and gas industry and to a rise in coal output. On the basis of very rich deposits, the Soviet people under party leadership within a short historical time have built large enterprises in these sectors. Over the last 15 years, fuel output in the nation has increased by over 2-fold, including

by almost [illegible]-fold for petroleum, by more than [illegible]-fold for gas, and by [illegible]-fold for coal. The output increases slated for the current five-year plan will be around 1[illegible] million tons for oil and gas condensate, [illegible] billion m^3 for gas, and [illegible] million tons for coal. The nation has in operation large oil and gas lines with a total length of over 1[illegible],000 km, and these have basically been built recently.

The increase in the fuel and energy potential and the improvement in the fuel balance are a determining factor in the further development of all the national economic sectors, in improving the efficiency of social production, and bettering the living conditions of the population. Suffice it to say that at present gas is being used as an intensifier in the smelting of more than four-fifths of the total quantity of iron, for the production of one-quarter of the mineral fertilizers, in producing plastics and many other types of chemicals. Gas has become part of the everyday life of 1[illegible] million Soviet people. Oil and gas hold the most important place in the economic relations of the countries in the socialist commonwealth.

At the same time, the nation's increasing demand for fuel and energy resources is being met with a certain strain, particularly in the winter period, and certain restrictions are being imposed in the supply of electric power to a number of enterprises. Of course, this cannot help but be felt in their operation.

The role and significance of the fuel and power complex in the system of the national economy are ever growing, the scale is broadening, and the tasks of its development are becoming more complex. The November (1979) Plenum of the CPSU Central Committee devoted particular attention to this key problem in a further rise of the nation's economy. The views and conclusions contained in the speech of the General Secretary of the CPSU Central Committee, Comrade L. I. Brezhnev, at the plenum are of fundamental importance. They concern such major questions as improving the fuel and energy balance, accelerating scientific and technical progress, a dependable supply for the growing needs of the national economy for fuel and energy, and raising the level of all work being done to economize them. Tasks have been set related to shaping future power production, to the broader use of nuclear, solar and geothermal power, and to developing the production of synthetic liquid fuel.

The documents of the Plenum of the CPSU Central Committee, having been given nationwide approval, now are the basis for the activities of the ministries and departments, enterprises, construction projects, scientific research institutions, party, soviet, trade union and Komsomol bodies on the spot.

Improving Production and Management in the Sectors

The fuel balance is formed over the decades. It influences the structure of all industrial production. An increase in the proportional amount of oil and gas in the balance has led, as is known, to a significant rise in

the efficient operation of power plants, metallurgical and chemical enterprises, to a rise in labor productivity, and to a radical change in the level of the everyday life of the workers.

How will the structure of this balance be formed in the future? The elaboration of the development prospects of the Soviet economy up to the end of the current century indicates that with a sharp rise in the output and production of fuel and energy resources, the share of oil and gas in the overall balance will obviously decline. We must work out a clear program for the further development of the fuel and energy complex. And here immediately several complex and interrelated problems and tasks arise and these must be solved immediately.

The most general and important problem for all the sectors of the complex is to improve production and to accelerate scientific and technical progress in every possible way. This can be shown, as is said, graphically and also from several different aspects.

Let us take oil production in the "old" regions of Azerbaijan, Turkmenia, the Ukraine, the Northern Caucasus, Belorussia, Tataria, Bashkiria and in Kuybyshevskaya and Orenburgskaya oblasts. Here entire cities have grown up on the basis of oil fields, expensive capacity has been built, and labor collectives formed. But, as is known, the output rate in these regions has begun to decline. At the same time here there are enormous reserves and at present the oil is far from fully depleted in the deposits. Can more be extracted? Undoubtedly so. For this it is essential to steadfastly work out and more widely employ progressive production methods, and more fully and properly employ the research forces of the sectorial institutes as well as the achievements of advanced practices. The continued operation of the old deposits will save the state many billions of rubles.

An equally complex task confronts the petroleum workers in the eastern regions. At present the increase in oil output in Western Siberia is basically being carried out by exploiting the previously discovered large deposits. In order to replace them in the future, it is essential to put scores of small deposits into operation. Calculations indicate that in 198[illegible], in accord with the nation's demands, the volume of drilling work must be more than doubled. If this is done with present-day equipment and at the existing rates, then the number of drilling workers must be increased by hundreds of thousands of persons. This is scarcely realistic. Hence, the one way is with new equipment, an improvement in production methods, and a rise in labor productivity.

The same can be said of the coal industry. Strip mining here is the most progressive and promising. However its proportional amount in the total volume of mined coal is still insufficient, and at present it does not exceed [illegible] percent. Our nation possesses enormous coal reserves suitable for strip mining. They exist in Eastern Siberia, the Kuznetsk Basin, Ekibastuz, and other regions. But it is essential to accelerate the fundamental technical reequipping of the coal industry and transport for a sharp rise in the rate of such mining.

The problems of improving production and the acceleration of technical progress in the sectors of the fuel and energy complex in the East of the nation are all the more acute as they are compounded by the problems of developing as yet uninhabited areas and improving the ways for delivering the extracted raw materials to the consumption areas.

There are a number of such large-scale questions in the further development of the fuel and energy complex. But in addition to the problems of a technical improvement in production which demand an improvement in management. At present the oil and coal industries are not providing the required increases in output. A number of enterprises in the Ministry of Petroleum Industry (Minnefteprom) have not fulfilled the 1979 quotas. The greatest lag was committed by the Bashneft' (Bash. Petroleum), Mangyshlakneft' (Mangyshlak Petroleum) and Krasnodarneftegaz (Krasnodar Oil and Gas) associations. The situation is no better in the USSR Ministry of Coal Industry (Minugleprom), where almost one-quarter of the production associations has not met the plan.

What are the reasons for the unsatisfactory operation of a number of enterprises in the fuel sectors? Of course, there are objective factors which must be mentioned. Thus, the severe weather conditions in the first quarter of 1979 played a negative role. Due to the electric power outages in Western Siberia and the Komi ASSR, the oilfield workers did not produce many hundreds of thousands of tons of oil, and 70,000 linear meters of wells were not drilled. The stoppages alone due to low temperatures in the open-air works in Siberia led to a shortfall of 400,000 tons of coal. There are also factors related to shortcomings in material and technical supply.

But all the shortcomings and failures cannot be explained solely by these factors. In a check it turned out that the leaders of certain associations, mines and fields committed many irregularities in preparing the workfront and sinking the shafts. There have been instances of the unsatisfactory development of capacity and the use of highly productive equipment, poor organization of production, negligence and a lack of discipline.

What tasks stem from the situation which has developed? The ministries and departments must first of all raise the management level of the sectors and enterprises and must improve the situation, having focused on the prompt and most efficient solution to the existing questions. It is essential to raise the personal responsibility of each leader for the conscientious and creative fulfillment of the duties placed on him and to strengthen the role of the boards as the collective management bodies of a sector.

These tasks in a most immediate manner stem from the Decree of the CPSU Central Committee "On a Further Improvement of the Economic Mechanism and the Tasks of the Party and State Bodies." This points to the necessity of increasing the organization and efficiency of all the economic units, achieving greater effectiveness in the activities of the personnel of the ministries and other management bodies, constantly raising state, production and labor discipline, and increasing the responsibility of the personnel for fulfilling the established plans and contractual obligations.

At present the production association is the basic element in management. For this reason the most important duty of the ministries and departments is to bring about an improvement in the activities of this unit, bearing in mind above all the vital organizing work of the association specialists at the enterprises and their daily help to the production workers. Certainly practice indicates that where the associations follow this path, the best results are achieved. Thus, the leaders and specialists of the Vostsibugol' [Eastern Siberian Coal], Gukovugol' [Gukovo Coal], Ordzhonikidzeugol' [Ordzhonikidze Coal] and Toreztantratsit [Thorez Anthracite] associations, in continuously improving the organization of production and labor and the preparatory engineering mining work, and in raising the role of the section chiefs and brigadiers, have ensured the fulfillment of not only the plans but also the additional quotas and increased socialist obligations.

The production associations must not be allowed to replace vital and effective leadership with paperwork or a pile of questions and orders. Unfortunately, this does happen. For example, the Krasnodarugol' [Krasnodar Coal] Association in one month alone sent more than 200 documents to the Mine Administration imeni Lyutikov. Here the measures often contradicted one another, and the personnel was little concerned with the inspecting and organizing of fulfillment. The leaders of certain departments of the association and the directors of the enterprises were very seldomly at the mines. Is this any way to provide normal leadership over a dynamic mining organization? It is not surprising that failures in fulfilling the quotas are observed here.

A low level of economic and technical leadership is also characteristic for the Kuznetsugol' [Kuznetsk Basin Coal] and Krasnoarmeyskugol' [Krasnoarmeysk Coal] associations. At many mines production and technological discipline is violated, the plans for carrying out preparatory work are not fulfilled, personnel turnover has been increasing, and the state of mining has deteriorated due to a weakening of the engineering service.

It is bad enough when the plans are not fulfilled episodically, but it is even worse when they are not fulfilled systematically. Precisely such a situation has developed at certain enterprises of the coal and oil industry. The reasons for this are often rooted in the unsatisfactory use of fixed capital, in the ineffective introduction of new equipment, the slow development of designed capacity, and in various management oversights. The ministries and the leaders of the associations should work out the necessary measures specifically for each enterprise which does not reach designed capacity and achieve a decisive improvement in the use of equipment.

It is essential to accelerate the search for the means and solutions which, as was already said above, would lead to more rapid growth of production efficiency and to more tangible technical progress in the fuel sectors of industry. Along with this it is important to apply as much effort as possible to disseminating advanced experience which is an enormous reserve for

the growth of production and for improving the efficiency and quality of the work.

In the coal, oil and gas industries and in peat mining there are remarkable production leaders whose experience shows in practice what high results can be achieved with the skillful use of the equipment and well thought out and scientifically sound organization of labor. As an example, take the movement of the brigades and sections for mining a thousand and more tons of coal per day from one working face. This movement, as is known, was approved and supported by the CPSU Central Committee and was highly praised in the speeches of Comrade L. I. Brezhnev and in his greetings to the leading mining collectives. Over the 10 years it has become a powerful factor in the development of the coal industry. At present there are 435 such brigades in the sector. They bring to the surface around 40 percent of the coal from all underground mining from working faces, although the number of miners in them is just 15.7 percent of all those employed in this work.

However, serious shortcomings have been discovered in the development of the "thousander" movement. We cannot help but be alarmed by the fact that recently there has been a tendency in the sector for a decline in the number of brigades and sections producing 1,000 and more tons of coal per day from one longwall. In 1979, there were not 435 but rather 407. One might ask why the won positions are now being surrendered in the sector? Does this not show certain miscalculations of the ministries and the leaders of the associations and enterprises in the organization of labor and production?

Certain enterprise leaders give very great attention to achieving record indicators in individual brigades and sections, creating better conditions for them and forgetting that this has a negative effect upon the mood of other collectives and ultimately on the work results of the entire enterprise. There have been instances when the initially assumed obligations are not revised when two mining brigades are combined or the personnel of the brigade is increased. Unfortunately, the working conditions under which the successes were achieved often are inaccurately described in the press or over the radio and television.

Practice indicates that better results are achieved by those enterprises where the leaders show constant daily concern for creating conditions for the productive labor of all the brigades and sections. Thus, at the Nagornaya Mine, the Mine imeni Kostenko and the Mine imeni 50-letiye Oktyabrya there are no laggards, and all the collectives of the sections and brigades overfulfill the plans and established output standards. Here due to the across-the-board introduction of advanced methods for the organization of labor, to the better utilization of mining equipment and to improving the vocational skills of the miners in all the working faces an output of 1,400-1,800 tons of coal per day has been achieved. This has made it possible to significantly improve the technical and economic indicators as a whole for the enterprises. And at the Mayskaya Mine (the Rostovugol' [Rostov Coal] Association), the workers of which were

congratulated in November on the early fulfilling of the 4-year plan of the five-year plan, by Comrade L. I. Brezhnev, there are not only no lagging sections, shops and brigades, but even individual workers; designed capacity has been significantly exceeded. Great successes have been achieved by the collective of the Vorgashorskaya Mine operating under difficult Arctic conditions.

In collectives where a more advanced organization of labor and production is employed, operating time of the combines is 40-45 percent of the length of the work shift, while in many faces equipped with mechanized complexes, it as yet does not exceed 20-30 percent. At a number of mines, four-shift working conditions have been established, and this makes it possible to establish a special repair shift. But many enterprises have not used this opportunity. Last year almost one-half of the fully mechanized faces operated in violation of these conditions, without a full repair shift.

In all the sectors of the fuel and energy complex, capacity continues to increase and extensive and diverse construction is underway. But the pace of this work as yet is insufficient and the capital investments envisaged in the plan are not fully used. There still are problems in supplying these sectors with equipment, pipe and other materials. Serious complaints have been voiced over the quality of the equipment and products supplied by the USSR Ministry of Chemical Machine Building, the Ministry of Electrical Engineering Industry and the Ministry of Ferrous Metallurgy.

Recently the party Central Committee and the USSR Council of Ministers have worked out a number of measures to further develop the Donets, Ekibastuz and Moscow basins, the Prokop'yevsk-Kiselevsk region in Kemerovskaya Oblast, and to improve operations at the oil and gas deposits in Western Siberia. The ministries and departments must strengthen their activities in carrying out the planned measures. The party bodies of these regions also have much to do.

To Raise the Responsibility of the Personnel

Success is determined by the people or the personnel. The end results of enterprise operations depend upon the preparedness of the personnel and economic leaders, upon the level of work in the collectives, and upon the efficiency and teamwork of the entire economic mechanism. The party obkoms, raykoms and gorkoms, and the primary party organizations direct all the organizational and political work in the collectives. It is they who must, as is pointed out in the Decree of the CPSU Central Committee "On Further Improving Ideological and Political Indoctrination Work," contribute actively to successfully solving the historic task of uniting the advantages of socialism with the achievements of the scientific and technical revolution, generalize and broadly propagandize advanced experience, and work constantly for the strengthening of labor and state discipline, for increasing responsibility for the assigned job, and against wastefulness, a narrow departmental approach and localism.

An improvement in the quality of this work is particularly important for the party organizations of the sectors and enterprises in the fuel and power complex, the development of which is viewed by the Communist Party as one of the fundamental tasks.

The party committees of all levels must give primary attention to the questions of developing the fuel sectors of industry. Everyone, as Comrade L. I. Brezhnev pointed out at the November (1979) Plenum of the CPSU Central Committee, must understand that the covering of the growing needs of the national economy for fuel is not a departmental problem but a national problem. From this it follows that everything necessary for the normal operation of the fuel enterprises must be carried out first.

The training, indoctrination and placement of personnel are a key task for the party committees. The sectors of the fuel industry have developed strong and highly skilled personnel of managers, engineers, technicians, miners, petroleum, gas and construction workers. Their ranks are constantly being filled out with young specialists who have graduated from the higher and secondary schools. At the same time there are numerous flaws in the work with the personnel, particularly in retaining them, in these sectors. For example, at the enterprises of the coal industry there is a very high turnover rate of leaders, including among such employee categories as mine chief and chief engineer.

In his speech at the November (1979) Plenum of the CPSU Central Committee, Comrade L. I. Brezhnev drew attention to the necessity of improving the utilization of labor resources. This is also a very urgent task for the sectors of the fuel and energy complex, where losses of working time are still high. There is still the shortcoming of the unnecessary diverting of engineers, technicians and enterprise leaders to all sorts of meetings and conferences. As a result of this, immediate control and leadership over production are weakened, and this leads to undesirable consequences. It is essential to raise the role of the engineer, and show more concern for creating conditions for creative and fruitful work. On the other hand, the party committees should demand better production management from the economic leaders and engineers. The leader of a mine or oil field should employ each hour of his work day rationally and efficiently.

An important task of the party and economic leaders is to work out and implement integrated measures aimed at retaining skilled personnel and creating proper working conditions at the coal mines and in the oil and gas industry. Certainly often precisely working conditions are the decisive ones. For this reason the greatest possible concern must be shown for mechanizing heavy and labor-intensive processes, and the ministries must work out measures to more fully utilize the mechanization and automation, while the local party bodies must strictly monitor their fulfillment.

One of the decisive means for retaining personnel is the construction of housing and cultural and service facilities. This is being carried out on

on ever broader scale. The state has shown great concern for this. But the pace of construction work still does not meet the demand.

The housing construction plans are not being fulfilled in the Kuznetsk and Karaganda coal basins and in other regions. The party committees should place greater demands upon the implementing of these plans.

Each party committee must know the state of affairs at the enterprises of the fuel sectors of industry, the mood in the labor collectives, and take the corresponding measures to improve work. The questions related to the activities of these enterprises should constantly be at the center of attention of the bureaus of the party obkoms, gorkoms and raykoms. The duty of the party committees is to work for the complete and most efficient use of the available production capacity, and the prompt completion of the projects, and provide control over the fulfillment of the taken decisions. Where the party committees are deeply involved in organizing the question and provide constant control over the fulfillment of the planned, as a rule the necessary result is achieved here.

Unfortunately there are also instances when the party committees for a long time have tolerated serious shortcomings in the operation of the enterprises and construction organizations, they have not taken decisive measures to eliminate them, and do not place proper demands upon the leaders. Above mention was made of the elaboration of measures to further develop the fuel and energy base in individual regions. The course of carrying them out in a number of places still cannot be considered satisfactory. The situation must be so arranged that the implementing of the planned measures is constantly under the control of the party obkoms, gorkoms and raykoms, in order that the corresponding departments of these committees analyze the developing situation, make a fundamental assessment of the work, and undertake exhaustive measures on the spot to carry out the quotas.

The enterprises of the coal, petroleum, gas and peat industry and the construction organizations of the Minneftegazstroy [Ministry of Construction of Petroleum and Gas Industry Enterprises] employ almost 400,000 communists. They are the militant vanguard of collectives which have been tempered by difficulties. The communists unite the people at the fields under the severe conditions of the North, in overcoming all sorts of obstacles in laying the oil and gas lines, and in the difficult underground work. With a feeling of great duty to the motherland, they set examples of self-sacrificing labor. At present the entire nation knows such masters as the brigade leaders of the mining "thousander" brigades G. I. Smirnov and M. I. Chikh, the brigade leaders of the drilling brigades G. M. Levin and G. I. Petrov, and many others. These are exemplary communists, organizers of their collectives, able mentors and production innovators who blaze the trail to the highly productive use of the equipment.

As an example take the brigades of Comrades Levin and Petrov. They drill 80,000-100,000 linear meters of shaft per year, while the average drilling for Glavtyumenneftegaz [Main Tyumen Administration for Oil and Gas] does

not exceed 35,300 meters. Is this not a model of highly productive labor? But we do not mention this merely to again bring up the already famous innovators. Here the party, trade union and economic leaders have cause for reflection.

Of course, it is to the good that the names of these pacesetters have been known for years. This means they are firmly holding on to their positions. But one asks why are there so few new names? Does this not show that the party organizations are not manifesting proper tenacity, stubbornness and ability in multiplying all the new, advanced and progressive?

And we speak primarily of the party organizations because the dissemination of the experience of the pacesetters is inseparable from a strengthening of the vanguard role of the communists in production, and from their fulfillment of the obligations which are clearly outlined in the party Bylaws. Here there are many shortcomings of the party organizations. Thus, the achievements of the pacesetters in the oil and gas industry still are not being widely disseminated. A major reserve, thus, remains untapped.

The dissemination of advanced experience must be closely tied to the brigade form of the organization of labor, to raising the role of the foreman and brigade leader in production, and the strengthening of labor and production discipline.

It must be recognized that we do not sufficiently popularize the experience of the innovators and advanced collectives in the press, radio and television, and we are not finding new, effective and attractive forms for this work. And this question is an extremely important one. The party organizations and all the mass information bodies must show significantly more attention to it.

It is essential to extend the socialist competition between the coal basins, the individual mines, oil fields and brigades, we must more often publicize the comparative results, and not be afraid of mentioning the shortcomings. All of this undoubtedly will be of important significance for the exchange of experience, for improving the effectiveness of the competition and for raising the overall indicators.

For the Rational and Economic Use of the Fuel and Energy Resources

The rational and economic use of fuel and energy resources is a major reserve for increasing them. Each ton of coal, oil, gasoline, each cubic meter of gas and kilowatt hour of electric power is produced at a high price of human effort and great expenditures of material and financial means. Even at the dawn of Soviet power V. I. Lenin pointed out that "... each pud of bread and fuel is a true sacred thing...."

The party and government have constantly focused the party, trade union and economic bodies, the leaders of all the national economic sectors and all the enterprises at the strictest observance of thriftiness, and of the most

careful attitude toward the common weal, and in particular to the expenditure of fuel and energy resources. As is known, specific integrated programs will be worked out as the most important component of the state long-range economic and social development plans of the nation. And the program for saving fuel and metal is viewed among the primary ones in the immediate future.

The party Central Committee has always given enormous significance to disseminating the experience of the party and economic bodies in the area of saving energy. For example, in 1978, the CPSU Central Committee reviewed in detail the question of the organizational and political work carried out by the Kemerovskaya party obkom in the area of saving fuel and energy resources at the oblast enterprises and construction projects. In the approved decree it was recommended that the central committees of the Union republic communist parties, the party kraykoms, obkoms, gorkoms and raykoms, as well as the party committees of the enterprises and construction sites critically analyze the state of work in the production collectives to increase the fuel and energy resources and to consume them rationally.

The party organizations were confronted with the demand of ensuring the unconditional fulfillment of the plan quotas for saving fuel and energy, and to decisively halt instances of mismanagement, waste and any sort of excesses in their use. It must be seen to that this work becomes a daily question for our cadres, workers, kolkhoz members, specialists, and all workers. Thus the party Central Committee again and again stresses the notion that this struggle for savings is no brief campaign but rather a method of socialist management.

In being guided by the designated decree and other documents, the party committees of all levels and the primary party organizations have carried out great work in this area. Many labor collectives of Moscow, Leningrad, the Ukraine and Belorussia, Chelyabinskaya, Gor'kovskaya and other oblasts have made valuable starts in strengthening thriftiness. Measures have been worked out for each ministry, department, and industrial enterprise, and these provide for a technical improvement of production, the use of progressive consumption standards, and the fuller utilization of secondary fuel and energy resources.

Much has been done. However, not all the national economic sectors and far from all the enterprises are carrying out the measures stipulated by them. There is no need to give many examples. Suffice it to say that, as a check showed, over the [illegible] months of last year alone, the thermal power plants of the USSR Ministry of Power and Electrification overexpended [illegible] tons of fuel units as a consequence of the underfulfillment of the plan quotas to reduce the proportional standards. A number of ministries and departments have not shown proper tenacity in applying technically sound fuel and electric power consumption rates at the enterprises. It must not be forgotten that an increase in electric power output, the mining of coal, oil, gas and peat, and their rational and economic consumption are two aspects of one and the same important national economic problem.

Of course, it is essential to struggle more decisively against mismanagement and waste. But the necessity has arisen, as Comrade L. I. Brezhnev has pointed out, of raising all the work in the area of saving fuel and energy resources to a qualitatively new and higher level, and approach the solution to the problem in a more fundamental manner. On the basis of scientific and technical achievements, it is essential to ensure a constant decline in the proportional fuel and energy expenditures for producing the product, to raise the efficiency of engines and energy units, and to utilize secondary energy resources and thermal waters more completely.

Attention to the use of secondary resources is still very slight. The quotas and measures in many production sections are not carried out, and large energy losses are permitted. Thus, in 1979, 7 percent of the total volume of useful secondary fuel resources was lost. Secondary thermal resources are even more poorly utilized. Out of their total quantity in the same year, only [illegible] percent was recovered, and only 20 percent in the gas industry.

It is time to change the existing notion of natural gas as a virtually free fuel. Gas is a most valuable raw material. According to the estimates of specialists, each thousand cubic meters of gas employed at electric plants instead of coal saves from 4 to 5 rubles, and the savings from the consumption of the same quantity of gas as a raw material or for production needs is from 40 to 90 rubles. The difference, as can be seen, is enormous. We must put a stop to the wasteful use of gas.

We can no longer be satisfied by merely setting quotas for the saving of fuel and energy resources and the utilization of secondary ones. There must be a profound and thorough approach using technical, production, construction and other effective measures.

The party committees must head the organizing of this work on the spot. From the example of the Ukraine, in each oblast responsible groups or commissions should be set up for regulating the use of fuel and energy resources and for monitoring their transporting, particularly in the wintertime. It is also essential to work out an integrated program of concrete measures aimed at reducing fuel and energy consumption, and employing them rationally in all spheres of consumption, in each city and rayon.

The final year of the Tenth Five-Year Plan has commenced. The regular session of the USSR Supreme Soviet approved the economic and social development plan of the nation for this year. Quotas have also been set for a significant increase in the output of electric power, and the mining of coal, oil and gas. Much effort must be made to carry out what has been planned. In endeavoring to celebrate the 110th anniversary of the birthday of V. I. Lenin by new successes, the workers of the city and countryside will accept increased socialist obligations. The collectives of the enterprises in the fuel and energy complex are starting up a competition to properly celebrate the noteworthy date. It is the duty of the party

organizations at these enterprises to increase the effectiveness of the socialist competition and ensure the unconditional fulfillment of the quotas for each month and each day. This will be the guarantee for the successful completion of the plans for the concluding year of the five-year plan and a dependable basis for a further rise of the economy in the forthcoming 11th Five-Year Plan.

10272
CSO: 1820

ELECTRIC POWER

ANTONOV ON PROBLEMS, PLANNING FOR ELECTRICAL EQUIPMENT INDUSTRY

Moscow PRAVDA in Russian 3 Sep 79 p 2

[Article by A. Antonov, Minister of the Electrotechnical Industry of the USSR]

[Text] The resolution of the Central Committee of the CPSU and the USSR Council of Ministers "On Improvement of the Planning and Intensification of the Influence of the Eco. Accounting Mechanism on Improving the Efficiency of Production and Quality of Work" is a new phase in the improvement of the methods of control of the national economy. The entire content of this resolution is aimed at the maximum use of the results of scientific and technical progress -- a powerful lever for increasing social production. The experience of all branches of the national economy has been concentrated in it, including the experience of electrotechnical industry with respect to increasing the effectiveness of science and engineering, accumulated during the course of the large-scale economic experiment started 10 years ago.

The electrotechnical industry is characterized by multiple nomenclature, large-scale and varied nature of production, a developed scientific base, complex economic and personnel structure, intrabranch and interbranch communications. By what paths have we arrived at the creation of the integral control system for scientific and technical progress?

The first step was the radical organizational reconstruction of the branch, above all, its scientific base. Eighteen scientific and technical centers were set up to be responsible for the solution of the large-scale national economic problems. The process of the integration of science and production proceeded in parallel: half of the institutes and the planning and design subdivisions were transferred to direct subordination to industrial enterprises.

The concentration of scientific forces, the strengthening of the material base permitted, for example, one of the leading centers of the branch, the All-Union Electrotechnical Institute imeni V. I. Lenin, successfully to solve such complex problems as the creation of sets of electrical equipment for ultrahigh voltage for superlong range electric power transmission lines.

Another example, the All-Union Scientific Research Institute of Electromechanics, with the active participation of the specialists of the CEMA countries, [illegible] the creation and the industrial assimilation of a unified standardized series of asynchronous motors of up to 100 kilowatts.

The second step was the introduction of a more flexible, complete planning and financing system for new equipment ensuring continuity of the [illegible] with respect to the entire cycle "from the idea to introduction." In the initial planning document, the final goal of the project, the composition of the executive agents, the amounts of financing, the completion times and planned cost benefits are defined.

The growing requirements of the consumers for the complete delivery of electrical equipment began to be met by the planning system. The organization of operations was invested in the head scientific and technical center, empowered by the auxiliary rules to act as coordinating agent, to finance and undertake legal work. Thus, the basic reference point became the final result -- the creation of standardized series of (electrical) equipment.

The conversion to complete planning of the new equipment required improvement also of the methods of financing the scientific research and experimental design work. The financing began to come from a unified fund for the development of science and engineering formed at the expense of deductions from the profits of the enterprises with respect to a defined normative and at the expense of means supplied by the customers in accordance with the economic agreements. This made it possible for the ministry to completely abandon appropriations for the state budget and to have [illegible] the means of solving the most important problems with greater mobility.

The sources for the formation of the economic incentive funds became reduced production cost and additional profit in the form of allowances added to the wholesale price for new products in the highest quality category. The size of the deductions to these funds is established depending on the actual cost benefit obtained, on the one hand, from the consumer user and on the other hand, in the branch itself as a result of the technical progress measures.

In recent years the effectiveness of the means from the unified science and engineering development fund used to finance scientific and technical progress has tripled. The branch has received a mobile source of means which permits in more optimal times the development and implementation of the most important targeted programs for the assimilation of new equipment from scientific research to introduction into production.

The most important area of our activity became the formation of a branch quality control system to which we had resorted before the beginning of the economic experiment. The production volume output in the branch with respect to quality categories began to be confirmed by the directive agencies on the level of the national economic plan. All of this permitted

[illegible] times, increase in the production output in the highest quality category.

In [illegible] the cost benefit from introducing new types of production exceeded by almost [illegible] times the results obtained before the beginning of the experiment in 1966, and it amounted to [illegible] billion rubles. The time from research to assimilation of the experimental lot of products has been reduced by [illegible] times. The cost benefit on the average for one new product almost doubled. This year the proportion of the production in the highest quality category in the overall production volume will be [illegible] percent.

The productivity of labor and profitability increased. As a result of reduction of production cost on the basis of the achievements of scientific and technical progress, the wholesale prices for electrotechnical products dropped. This provided economically more advantageous conditions for the introduction of innovations into the national economy.

During the process of the introduction of the economic methods of control it was discovered that the individual principles require more exact definition. For example, the existing scale for giving bonuses, depending on the magnitude of the cost benefit obtained did not fully take into account the interests of the enterprises in undertaking large-scale measures leading to a considerable economic effect. It was more advantageous for the enterprises to take measures "greater in number and more costly in price," for they obtained large deductions to the bonus fund from their introduction. Subsequently the incentives were optimized.

The resolution of the Central Committee of the CPSU and the USSR Council of Ministers has outlined a clear program for strengthening the role of economic levers and incentives. This will provide new impetus to scientific and technical progress. It must be stated that in the first phase we have not been able to come up with the final solution to all of the problems. Serious deficiencies existed primarily in calculating such estimated indexes as the gross production and the growth rates of the productivity of labor, the wage fund and a number of other indexes determining the cost accounting conditions of the operation of the enterprise and the organizations and also the branch as a whole reckoned on the basis of the gross production. It is known that the practice of calculating these indexes has not created the required economic interest of the enterprises in introducing new equipment into mass production. Now these deficiencies will be eliminated inasmuch as new estimated indexes are being introduced.

The methodology and practice of planning new equipment on the level of interbranch communications have not been developed. Insufficient coordination of the times for assimilation of the new equipment, the component parts of which are created by various branches of the national economy has often held up mass production of them. A characteristic example is the assimilation of the series production of a new series of AC electric motors. By comparison with the previous series they permit a reduction in the

consumption of metal and a decrease in electric power losses. The uncoordinated efforts to work with adjacent branches have led to the fact that the conversion of the branch to production of the new product has been delayed unjustifiably.

The accumulated experience and analysis of the deficiencies of the system have made it possible to determine the basic areas of further improvement of branch control. In 1979 we began a new phase of economic experimentation. Various refinements were introduced into the planning system. A theoretically new element in the development of annual plans is the fact that it will be based on stable economic normatives approved in the five-year plan for each year. The introduction of these normatives will promote expansion of the economic independence of the enterprises and the branch as a whole. In the new phase of experimentation the growth rates of the volumes of industrial production and the productivity of labor are estimated considering the effectiveness of the new product in comparison with the one being replaced. The essence of this principle is the incentive to find the most advanced technical solution in order to insure a "gross effect" of highly efficient equipment.

Today serious work is going on in the branch aimed at having the accumulated experience in the control of technical progress become an organic component part of the new economic management mechanism. A new index has been introduced -- the magnitude of the cost benefit obtained as a result of improving the organizational and technical level of production. This is stimulating the introduction of advanced technology, advanced techniques and modern forms of control at the enterprise.

Provision has also been made for measures to strengthen the effect of other economic levers on the acceleration of scientific and technical progress such as additional rewards for the most efficient use of materials and manpower, raising the role of bonus surcharges on the wholesale prices for new products, stiffening the sanctions for the production of low-efficiency, obsolete products, the introduction of additional pay for supernormative remainders of fixed productive capital and circulating capital.

The preparation of the system of economic normatives is being completed, the instructions and procedural materials have been developed and are agreed on with the planning agencies.

The improvement of planning and incentive for production, the increase in the role of the five-year plans, and the introduction of long-term economic normatives are continuously connected with the expansion of the area of application of cost accounting. Therefore the new complex system provides for the further development of cost accounting mechanisms, the intensification of their influence as a united production-economic organism. The strengthening of the cost accounting principles mentioned in the resolution of the Central Committee of the CPSU and the USSR Council of Ministers will create economic prerequisites for deep maneuvering and concentration of scientific and productive potential in the main areas of scientific and technical progress.

CSO: 1821

CONSTRUCTION PROBLEMS AT EKIBASTUZ ENERGY COMPLEX

Moscow EKONOMICHESKAYA GAZETA in Russian No [illegible] May 79 p [illegible]

[Article by A. [illegible], V. [illegible]]

[Text] First secretary of the Ekibastuz City Committee of the Communist Party of Kazakhstan [illegible] talks about the construction of the Ekibastuz Fuel and Energy Complex (ETEK).

"Gennadiy Alekseyevich, we see that you have an interesting photograph. It says: 'This is where the first power plant of the Ekibastuz power cascade will be constructed.'"

"It might be said that this is already an archive. I also have the last photograph: the State Regional Electric Power Plant building, and there is a sign on it that reads: 'Produce 1 million kilowatts in 1979!' They started from zero, and now the construction site has developed, and its scales are enormous.

"We shall erect a complex which has no analogs in world practice. The power of our five state regional electric power plants will be 20 million kilowatts. The power of the Ekibastuz coal beds — their budget reserves are more than 7 billion tons — will permit us to obtain high quality power fuel. It will be burned locally, in the area where it is extracted. This is an enormous cost benefit.

"Today the collective of the Ekibastuzenergostroy Construction Trust numbers about 11,000 people. The Ekibastuzshakhtostroy Combine is building the sixth phase of the Bogatyr' coal section, the largest in the world.

"Now about the city itself. In a short time new microdistricts have grown up in Ekibastuz; the power engineers and mine builders live here. The city is growing not by the day, but by the hour. Its population has already reached 75,000. These are primarily young people.

"Although new people are always arriving at the construction site, there are still not enough hands.

"On the example of the people from [illegible], many of the graduates of our schools are working at the construction sites of the city. Most assuredly, each class has its leaders. This year we have put together the real team of graduates who have decided to work on the construction of the [illegible] complex. All of these young people have joined the Komsomol youth collectives. They have the desire to learn further, going to the evening division of the branch of the [illegible] Industrial Institute and the Mining Technical High School."

"[illegible] Alekseyevich, it would be interesting for the young people who have decided to link their fate to the construction of the complex to see what [illegible] will be like tomorrow."

"I have already stated: the cascade of hydroelectric power plants has been designed for local fuel. The deposits of [illegible] and [illegible] coal here are quite large. Even with intensive extraction they will last a hundred years.

"Expensive fuel, expensive electric power... Already at the dawning of Soviet power Vladimir Il'ich Lenin noted: 'The main thing in all of the problem is [illegible] and its significance for the Urals.' It is true that the country could not immediately tackle such a bold and grand plan for the use of the [illegible] local coal deposits. There were simply not enough forces, equipment and available power. Now the time has come. It is no accident that in the resolution of the Central Committee of the CPSU and the USSR Council of Ministers 'On Improvement of the Planning and Intensification of the Effect of the Cost Accounting Mechanism on Improvement of the Production Efficiency and Work Quality,' emphasis has been placed on the necessity for proper determination of the priorities in the development of branches and economic rayons.

"About [illegible] people will live in the city. It is true that the location is not at all suitable for building houses: the engineering preparation of the sites is expensive. Therefore, [illegible] will have high-rise buildings. There are plans for erecting the most beautiful buildings for a dramatic arts theater and universal concert hall.

"Provision has been made for a park with a network of fountains. For rest and recreation there will be public amenities and a green belt along the shores of the lakes and [illegible] reservoir. They will be beautified by the yacht club and resort complexes. In short, [illegible] will not be inferior to the most developed centers of the country."

"A very impressive picture. However, let us return to the affairs and concerns of today. How do you consider that the beginning of this grand construction project was successful?"

"We have many difficulties. First of all, living conditions, the creation of normal working and living conditions for the construction workers.

"[illegible] living space. [illegible] by our own efforts, [illegible] a house building combine with a capacity of [illegible] square meters of living quarters a year will be constructed. Unfortunately, we do not always find understanding on the part of the interested ministry.

"I shall present an example. [illegible] This is expensive and [illegible]. Out of the variety of versions for the future we have selected [illegible] the opinions of the specialists [illegible]. This means the worker must get to the [illegible] station [illegible]. [illegible]

"We want to build [illegible]. The Komsomol members and young construction workers will help us do this. For example, on the initiative of the Komsomol committee [illegible] the young people have built [illegible] Komsomol building in their spare time [illegible]. Now the Ekibastuzenergostroy combine has started the construction of [illegible] building by the same method. Excellent initiative which we shall maintain.

"We are also offering [illegible] to the workers. It is difficult to grow gardens [illegible]. [illegible] but it is poor in vegetation. Several kilometers from the city [illegible] already ready for the [illegible].

"This is now the [illegible] period at the construction site. On the [illegible] of September the first power unit of the Ekibastuz State Regional Hydroelectric Power Plant (GRES-1) will be started up, and on [illegible] December, the second unit. These units have a capacity of 500,000 kilowatts each.

"Recently I visited the [illegible] of the main building of the GRES-1. Here the Komsomol [illegible] installation workers of [illegible] under the motto: '[illegible]'. It appealed to all [illegible] brigades of Ekibastuzenergostroy to support them. And at that time the construction [illegible]. It was considered that there were [illegible] shifts [illegible] by the [illegible] of September. [illegible] made the following resolution: 'Let each unit [illegible] start-up [illegible] shock shift.' All the brigades of the power construction workers [illegible] them.

"The results of the socialist competition among the Komsomol youth collectives were examined at a plenary session of the party [illegible]; the labor competition of the youth under the motto of 'The times for starting planned by the party are law' was approved. The power construction workers are now competing for the right to [illegible] the first power unit, and the mine workers, for the right to send the first train load of coal for the Ekibastuz GRES-1."

"Gennadiy Alekseyevich, the question of the young people from Vyacheslav Moiseyev's brigade is why [illegible] in the city? Will they at least build a movie theater in the near future?"

"We are indebted to the construction workers. There is still only one palace of culture for miners in the city with a capacity of 400. What does this mean for such a rapidly growing city? Indeed thousands of young people are now working and living in our city. After work they want to see a show or engage in sports. There is only one sports hall in the city! I myself, for example, love hockey. I played before. Now there is simply nowhere to get on the ice. The Ekibastuz soccer team is class B, the championship games are played at a primitive stadium. We do not understand why the Kazenergoproyekt Institute has delayed up to now the planning estimate documents for the construction of a stadium with a capacity of 11,000, for the construction of the sports complex. The institute was supposed to provide us with this documentation at the beginning of the year.

"Now we have started to build the palace of power engineers with 1,200 seats. We shall try to provide the simplest sports structures.

"There are perhaps more weddings in Ekibastuz than in any other city. New families are being created and this is good. Children are appearing. However, there are not enough kindergartens and nurseries. I wish to note that the decision has now been made to build new ones by the most advanced designs — with pools. We shall try if possible to see that the presently existing kindergartens have pools. Considering the peculiarities of our power city, we need additional means for building children's combines.

"In the joint resolution of the Office of the Central Committee of the All-Union Lenin Young Communist League, the Board of the Ministry of Power Engineering and Electrification of the USSR and the Board of the USSR Ministry of the Coal Industry, in particular, it was noted: 'Regularly direct the brigades of organizers of physical culture, scientists, trainers, leading athletes, veterans of the sports movement for participation in the organization and performance of mass sports work, the introduction of GTO complexes, the development of military engineering types of sports... Give practical assistance in the equipment with the required sports inventory and equipment for the sports bases and clubs of the city of Ekibastuz. Hold literature days in Ekibastuz together with the USSR Writers' Union. Commission a group of poets, writers and journalists to create works about the young construction workers...'

"It is impossible to say that the items of this resolution which is very important for us have not been fulfilled. For example, the Artists Union of Kazakhstan has already set up an exhibit in our city twice. However, other creative unions have unfortunately as yet not given their word.

"I express the opinion of all the young construction workers of Ekibastuz. Our construction site is worthy of a good, but unfortunately still unwritten song."

[illegible]
CSO: [illegible]

GEOTHERMAL ENERGY IN KAMCHATKA

Moscow SEL'SKAYA ZHIZN' in Russian [illegible] p 3

[Article by A. [illegible]]

[Text] I have before me a large physical map of the country. It is solidly covered with circles. There are an especially large number of them in the territory of Siberia, the Far East, the Caucasus, Kazakhstan and Central Asia.

"These all designate large hot groundwater pools, the temperature of which reaches 100° or more," explains candidate of geological and mineralogical sciences Viktor Germanovich [illegible], head of the laboratory of economics and development of new sources of power of the Institute of the Complex Fuel and Energy Problems under the USSR Gosplan. "It is easy to imagine what an enormous cost benefit the national economy would receive from using geothermal sources.

"Now there are more than 100 such deposits that have been discovered in the USSR. Many tens of billions of cubic meters of hot water are concentrated in them. Sooner or later people will use the energy in depths of the planet. It can provide billions of kilowatt-hours of electric power, heat cities, and supply agricultural complexes with heat. This will release tens of millions of tons of oil and billions of cubic meters of gas for other needs.

"This is a dream, but it is not a dream that is so remote or impractical. If we return to the reality today, then, for example, in Kamchatka the first experimental industrial electric power plant in the country has been operating since 1967 on the Pauzhetskiy geothermal spring. It supplies the Ozernovskiy fish combine and a number of settlements in the southern part of Kamchatka with power." Viktor Germanovich recently returned from an expedition there.

"Kamchatka is a territory of surprising natural contrasts," he says. "There are hot springs of rare beauty there. In the Valley of Geysers the columns of boiling water and steam erupt from the rocky banks of the

little stream which flows along the bottom of a canyon. Nature has created baths with hot healing water on the peninsula. There is snow all around, but people are still bathing."

Not far from Petropavlovsk-Kamchatskiy, in the vicinity of Paratunskoye deposit of geothermal water, hothouses have been built for growing vegetables. Up to 1200 tons of them now mature there. They are staffed with geologists, builders and fishermen. How important it is to have fresh vegetables on the table the year around in this severe area!

The institute collective has developed a complex program for the development of new energy sources and the application of them, in particular, in agriculture. It is calculated that the cost of one centner of vegetables grown in the hothouses using geothermal water is half that in the ordinary hothouses heated with mineral fuel. The expenditures on constructing the film hothouse of 500 square meters in area are returned in 3 years.

Now scientists are working on the problem of exploiting the heat in the magmatic centers of volcanoes. In the vicinity of the Mutnovskiy Volcano on Kamchatka 200,000 kilowatt geoelectric power plant will be built. The energy hidden in the Koshelevskiy volcano is being explored -- the plan calls for building a powerful electric power plant nearby.

Now let us go mentally to mountainous Dagestan. In the northern part of the republic is the Tersko-Kumskaya lowland where there are broad pasture lands. Often dry, hot winds raise dust and sand clouds here. The summer on the plateaus is usually hot. The livestock are short of water at times.

"Groundwater," says V. Khal'kolai, "is not very deep in this area, but it is too salty. Geothermal springs are coming to the aid of people here. There is an enormous pool of fresh water deep under the earth heated to 40-80° in some spaces. The groundwater heat is used in the winter by the animal husbandry complexes, and even the settlements."

In Dagestan, the city of Kizlyar is to be converted by the end of this five-year planning period entirely to geothermal water supply. The application of the abyssal heat of the earth under municipal conditions is five times cheaper than oil and gas. In Tbilisi, for example, one well services an area with a population of 5,000 people. And how much gas and electric power are saved by doing this! The air in the cities and settlements will become clean, and the forests, rivers and fields will not suffer from dust and smoke.

The fish feel good in the warm treated thermal water. The young fish develop twice as fast as in ordinary water. In a word, the scientists consider that the "steam boiler" of the earth has enormous possibilities and will provide much energy in the future.

10841
CSO: 1822

PROBLEMS WITH VOLZHSK HYDROELECTRIC POWER PLANT

Moscow PRAVDA in Russian [illegible]

[Article by A. [illegible], director of the Volzhsk Hydroelectric Power Plant imeni V. I. Lenin]

[Text] The electric power from the hydroelectric power plants is the cheapest, and their mobility, that is, the capacity to reach the maximum power in a matter of minutes, is hundreds of times higher than for thermal and nuclear power plants. This is especially important for automated control of the power system, primarily on occurrence and concentration of the "peak" loads.

However, this valuable advantage cannot always be used fully as a result of unsatisfactory starting capacity of the thrust bearings which bear the weight of the rotor and the water head which taken together amount to millions of kilograms.

At many of the largest hydroelectric power plants, including at the Volzhsk Hydroelectric Power Plant imeni V. I. Lenin, restrictions have been established for a number of units with respect to number of start-ups and even operating conditions. After 15-20 and sometimes two or three start-ups the unit must be shut down, the thrust bearing dismantled and repair work done. At our hydroelectric power plant prolonged operation at a load of [illegible] megawatts is not permitted on even one generator inasmuch as the thrust bearings could be damaged under these conditions. On the other hand, in order to reduce the number of start-ups, the operators do not shut down units even when it is not necessary to generate electricity. Hence, there are excessive expenditures of power or water.

The scientific research institute of the Leningrad Elektrosila Association has proposed a thrust-bearing design equipped with a hydrostatic system. The essence of it is that lubrication is fed between the segment and the surface of the pivot under a pressure of 100-150 atmospheres. This insures "ease" of start-up and shutdown of the unit. However, equipment of the unit with such systems requires additional expenditures and special equipment, they do not have 100% reliability, they are complicated and inconvenient for maintenance.

All of this has made it necessary to find means of creating simpler and more reliable thrust bearings. Knowing about the original work in material sciences done by the scientists of the Kuybyshev Aviation Institute, we requested that they undertake the necessary research and help in solving this difficult problem. They have responded actively to our request. They performed an analysis of the field studies of "large" units, they evaluated the causes of thrust-bearing defects and arrived at the conclusion that their reliability and fitness can be completely restored by using elastic metal-plastic bearings.

The proposal was adopted for its simplicity. The decision was made to check out the new idea experimentally using an analog, and then to perform field tests of the elastic metal-plastic segments in the thrust bearing of hydroelectric power generator No 9. Jointly with the Aviation Institute we developed a structural design for the segments, a set of them was manufactured by the mechanical workshops of the hydroelectric power plant with the help of Kuybyshev Metallurgical Plant imeni V. I. Lenin which had presses of the required power at its disposal. The tests performed in November 1976 demonstrated that the original design of the elastic segments made it possible to completely restore the fitness and reliability of a thrust bearing in all operating conditions of the unit. The thrust bearing, which was previously damaged after two or three start-ups, easily survived 10, 20 and 30 start-ups. Moreover, it did not in practice react to load conditions of 30 to 50 megawatts, which had not been permitted for even one unit of hydroelectric power plants.

The assembly and inspection demonstrated that the segments worked. The conclusion of the aviation plant experts that it is possible to return the reliability provided by the design and the operating requirements to the "large" units was fully confirmed. At the present time unit No 9 has operated for more than 27,000 hours, and its thrust bearing has withstood about 800 start-ups without damage.

In July 1977 the USSR Ministry of Power held an All-Union Conference of Power Engineers at our hydroelectric power plant on exchange of experience in the maintenance of the thrust bearings of hydroelectric power generators. Then the scientific and technical council of ministries adopted a resolution to expand the research, planning and design work to organize series production of new segments at the Cheboksary Energozapchast' Spare Parts Plant.

The joint work of the Kuybyshev Aviation Institute and the Volzhsk Hydroelectric Power Plant imeni V. I. Lenin was represented at the Exposition of Achievements of the National Economy, and it was awarded a gold medal. Later on, by their efforts (again with the help of the metallurgical plant), the thrust bearings of two more units of the Volzhsk Hydroelectric Power Plant, one unit of the Saratov Plant and one of the Bratsk Hydroelectric Power Plant were rebuilt. The specific load on them was increased to 60 kilograms per square centimeter in order to estimate the fitness of the new segment design under the most severe conditions which must be encountered at the most powerful high-head hydroelectric power plants. These tests

confirm the high reliability of the plastic segments. They have operated excellently in the thrust bearing of hydroelectric generator No. 7 of the Bratsk Hydroelectric Power Plant since December 1978. In January 1979, by the joint efforts of the [illegible] Aviation Institute and the Elektrotyazhmash Production Association, the fitness and reliability of the thrust bearing of hydroelectric generator No. 6 of the [illegible] Hydroelectric Power Plant having starting restrictions were completely restored.

Unfortunately, similar restrictions are still in force for the remaining units of one of the newest hydroelectric power plants and at a number of other hydroelectric power plants. This means that it is necessary to reequip the thrust bearing of the hydraulic generators more actively. However, we are running into difficulties here.

First of all, it is necessary to note once more that the pressing of the plastic coating for the set of segments for the [illegible] Hydroelectric Power Plant was again the work of the [illegible] Metallurgical Plant, for the USSR Ministry of Power does not have an appropriate press of its own. The materials for manufacturing the new segments were also difficult to obtain. There were insufficient reserves of them.

Nevertheless, the process of manufacturing the new segments is very simple. In the presence of a press of the required power and the required amount of materials, any machine building plant can organize series production of them. This means that the reliability and the starting mobility of the units of all the large hydroelectric power plants of the country will increase, the idle time for repairs will be reduced, and the electric power generation will increase. According to the data of [illegible], [illegible] hydroelectric power plants of the country are in need of increasing the fitness and the service life of the thrust bearings for hydroelectric power generators. The cost benefit from this will be millions of rubles per year.

In our opinion, the Ministry of Power, the Ministry of Electrical Engineering and the USSR [illegible] must respond immediately to the needs of the hydroelectric power engineers and tool up for series production of the new segments at one of the plants.

[illegible]
[illegible]

ELECTRIC POWER

SUPPLY PROBLEMS AT THE KOLYMA HYDROELECTRIC POWER PLANT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian [illegible] Nov [illegible] p [illegible]

[Article by V. Zhurba]

[Excerpt] In the future there will be an entire cascade of electric power plants on the Kolyma.

However, if the Kolyma Hydroelectric Power Plant is only the beginning, if a new power plant is to be started after it, if the oblast plans call for dozens of different construction sites, then is it not reasonable to have its own cement plant.

First, how many trucks are needed to supply fuel [illegible] kilometers to even the Magadan Heat and Electric Power Plant alone?! The coal delivered by water also has a surcharge, but it is still cheaper to obtain.

A parallel course is being followed: the extraction of fuel by the Severovostokugol' Association is increasing, and the importing of it from adjacent regions is also increasing. It is true that it is possible to change the situation if the Lankovskoye lignite coal field is put into operation. It is not [illegible] hundred but only [illegible] kilometers from Magadan.

The shortage of electric power in the oblast center will not be covered by rebuilding the existing power plant.

[illegible]
CSO: [illegible]

ELECTRIC POWER

BRIEFS

FIRST MHD POWER PLANT--The installation of a 500-MW turbogenerator was initiated in Ryazan'. This turbogenerator will begin to provide current in 1985 and will be the main element of the first industrial magnetohydrodynamic (MHD) electric power plant. This is one of the most prospective methods of directly converting thermal energy to electric power. It increases the economic efficiency of thermal electric power plants and represents a milestone in regard to environmental protection. [Text] [Warsaw ZYCIE GOSPODARCZE in Polish No 1, 3 Jan 82 p 14]

CSO: 2600

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EDITORIAL GIVES BRIEF HISTORY OF WESTERN SIBERIAN OIL INDUSTRY

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 3-4

[Editorial: "Western Siberia -- The Country's Main Oil Production Base"]

[Text] The Soviet oil industry has long evoked interest throughout the world because of the rate of its growth. It has been developed particularly rapidly since the second half of the 1960's, when the accelerated exploitation of the petroleum wealth of Western Siberia began. Since the first discoveries of oil and gas there, the CC CPSU and the Soviet government have devoted a great deal of attention to this region and have foresightedly perceived the prospects for its development. Assistance was provided in the organization of exploration and reconnaissance activities and the extraction of these useful minerals that are so important to the national economy has been developed.

In May 1962 the RSFSR Council of Ministers adopted the resolution "On Measures to Strengthen Geological Prospecting Work for Gas and Oil in Western Siberia," and in December 1963, the resolution "On Organizing the Preparatory Work for the Industrial Exploitation of Known Gas and Oil Deposits and on the Further Development of Geological Prospecting Work in Tyumenskaya Oblast." The latter resolution pointed out the necessity of organizing the experimental exploitation of known gas and oil deposits in 1964-1965. In order to do this, the Tyumen' Production Association of the Oil and Gas Industry (Tyumenneftegaz) was created in Tyumen' in 1964, after which drilling into the first oil deposits -- Trekhozernoye, Ust'-Balykskoye and Megionskoye -- began. At the beginning of June 1964, the first Tyumen' oil arrived at the Omsk Oil Refining Plant. During the sailing season of that year, more than 200,000 tons of oil was delivered to the plant. The year 1964 marked the birth of a new oil-producing region in this country.

The volume of drilling and construction work is growing by leaps and bounds. There remain to be solved many complicated problems having to do with exploiting deposits in an almost inaccessible region, organizing the material and technical supply of new enterprises, creating normal living, cultural and domestic conditions at the sites, and many others. Glavtyumenneftegaz and many oil industry institutes, along with other branches of the national economy, are actively participating in their solution. Western Siberia is becoming a nationwide construction project.

In view of the complexity and diversity of the problems that require operational solution and the considerable remoteness of Tyumenneftegaz from the developed regions, the decision was made to create in Tyumen' the Main Administration for Petroleum and Gas for the Tyumen' Region (Glavtyumenneftegaz), which began operating in the second half of 1965. A new Tyumenneftegaz association is being set up in the city of Surgut.

The goal of creating a large national economic complex in Western Siberia on the basis of the newly discovered gas and oil deposits, with an eventual oil extraction level of up to 20-25 million tons, was formulated at the 23d CPSU Congress.

During the Eighth Five-Year Plan, the industrial base for the development of Western Siberia's oil extraction industry was set up and the oil and construction organizations were supplied with equipment and high-mobility transportation facilities. The Shaim-Tyumen' oil pipeline was one of the first to go into operation, and was followed in 1967 by the Ust' Balyk-Omsk oil pipeline. The introduction of the Aleksandrovskoye-Nizhnevartovsk-Ust' Balyk oil pipeline in 1969 marked the beginning of experimental exploitation of the Samotlorskoye field.

The launching of oil pipeline operation enabled the oil workers to change from seasonal to year-round operation in all the regions being developed.

As a result of the selfless labor of geologists, gas and oil workers and construction workers, the 23d CPSU Congress's goal of creating a new oil base for this country was realized ahead of schedule. In 1965 less than 1 million tons of oil were produced in Western Siberia, but as early as 1970 the national economy received 31.4 million tons of Siberian oil. During the Eighth Five-Year Plan the Western Siberian oil workers sent 10 million tons of above-plan oil to the refineries.

While still in its first stage of development, in the last year of the Eighth Five-Year Plan Western Siberia provided approximately half of the nationwide increase in oil extraction. And, beginning with the Ninth Five-Year Plan, the oil industry of this harsh region was prepared to scale new heights. The goal formulated at the 24th CPSU Congress was a grandiose one: to create in Western Siberia the largest oil industry base in the country and to reach an oil extraction level of up to 120-125 million tons in 1975. In order to realize this goal it was necessary to solve a whole complex of new problems, because of the larger scale of development than was planned during the Eighth Five-Year Plan.

As a result of constant attention and concern on the part of the party and the government, creative collectives of oil, gas and construction workers were created in Western Siberia. Highly qualified specialists from Tatariya, Bashkiriya, Kuybyshevskaya Oblast and other oil regions of the country arrived to help exploit the Siberian oil. Constant association with science and the high degree of activity on the part of the specialists facilitated the development of new engineering and technical solutions.

aimed at overcoming the natural and climatic difficulties encountered in this region.

Practically from the beginning of the Ninth Five-Year Plan, the Ministry of the Petroleum Industry and Glavtyumenneftegaz have been studying possible and rational directions for the further development of western Siberia's oil industry. All of this activity has made it possible to achieve great successes. In the last year of the Ninth Five-Year Plan the nation received 148 million tons of western Siberian oil. From 1971 to 1975 the Siberians produced more than 44 million tons of oil above their assigned quota.

For its exemplary fulfillment of the party's assignment and the selflessness and labor heroism exhibited in connection with this, Glavtyumenneftegaz's collective was awarded the Order of Lenin in 1975. In his Summary Report at the 25th CPSU Congress, CC CPSU General Secretary and USSR Supreme Soviet Presidium Chairman L.I. Brezhnev gave a high evaluation to the labor of the conquerors of the riches of Western Siberia. "What has been done and what is being done in this harsh region is a genuinely great exploit. And to those hundreds of thousands of people who are doing it, the Motherland pays the tribute of admiration and heartfelt respect."

Inspired by the high evaluation of their work by the CC CPSU, as given personally by Comrade L.I. Brezhnev, the oil workers of western Siberia are continuing their persistent solution of the great problems that have been placed before them. In the 10th Five-Year Plan, they are faced with the task of more than doubling their extraction of oil. All of this is directly related to a significant expansion of drilling and construction work and the efficient organization of material and technical supply.

The further accelerated development of the oil industry planned by the 25th party congress opened a broad vista for the application of the forces of a multithousand army of workers in western Siberia. And they are achieving greater and greater successes.

In the spring of 1978, the billionth ton of oil since the beginning of the exploitation of the western Siberian oil region was produced. For this labor victory, L.I. Brezhnev warmly congratulated the workers, engineering and technical personnel, employees, party, trade union and Komsomol organizations of Glavtyumenneftegaz and the Tomskneft' association.

Feeling the constant concern of the party and the government, the oil workers of Siberia are organizing their work with due consideration for the prospects for developing that region's oil industry. They are studying the possible and rational directions for the further development of western Siberia's oil industry, determining, on the basis of the known resources of already discovered oil fields, rational and effective measures for putting them under development, setting, as their main goal, an increase in the oil industry's capacities in the new stage of development of the industry in this region. However, this is related to the solution of ever newer and

more complex engineering, technical and scientific problems in all areas of development of the oil industry.

In this issue, we present a selection of materials on various scientific and technical developments that are contributing to the development of this country's main oil production base, along with materials by authors from other oil-producing regions, the experience of which can be used under the conditions encountered in western Siberia. Part of the articles will be published in upcoming issues.

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METHODS FOR DEVELOPING OIL DEPOSITS DISCUSSED

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 25-28

[Article by N.A. Pravednikov, SibNIINP [Siberian Scientific Research Institute of the Petroleum Industry]: "On Some Propositions for Developing Oil Deposits"]

[Text] The 140 oil and gas-and-oil deposits that have been discovered in western Siberia are confined to Nizhnevartovskiy and Surgutskiy Rayons in the central Priob'ye, Shaimskiy Rayon in the Preural'ye, the southeastern parts of the western Siberian lowland, and the northern regions of western Siberia.

The deposits that are being developed are located in three oil-bearing rayons -- Shaimskiy, Surgutskiy and Nizhnevartovskiy -- and can be divided into two basic types by structure.

The Shaimskiy type includes oil pools that are confined to stratigraphic and depositionally truncated traps that taper out in the crest parts of the local structures. In most cases these are single-sheet deposits, the basic productive object of which is a stratum of basal sandstones "P" that lie on Tyumenskaya series sediments or directly on the substructure's weathering crust. The reservoir properties of the individual bands in the stratum differ sharply.

The central Priob'ye type of deposit is characterized primarily by sheet-arch deposits. They contain up to 20 productive strata that are comparatively persistent in area and profile. Their permeability is 200-1,000 md (the BS_1, BS_{2-3}, BS_4 and BS_6 strata in Surgutskiy Rayon and the BV_8 horizon in Nizhnevartovskiy Rayon). One exception is the B_{10} horizon, which is regionally disseminated throughout the entire Central Priob'ye and is characterized by severe dissection, discontinuity, the presence of replacement zones or complete tapering-out, and poor reservoir properties (permeability = 10-150 md). The group "A" horizons inside the Nizhnevartovskiy and Surgutskiy arches also have complex structures.

Extensive water-and-oil zones are inherent to all the productive strata in this group, and for several deposits (Samotlorskoye, Var'yeganskoye and Bystrinskoye, for example) the gas caps are of considerable size.

The oil from the deposits being developed in western Siberia falls into the low-density (0.78-0.89 g/cm³), paraffin-base (1.9-5.3 percent), low-sulfur (0.3-1.2 percent) category. The viscosity under bed conditions varies from 0.4 to 6.5 cp and its degree of gas saturation is 45-110 m³/t.

Starting with the special features of the productive horizons' geological structure and western Siberia's climatic and natural conditions, scientific workers and production personnel from this region and the branch as a whole combined their efforts to develop basic propositions for the exploitation of the oil deposits, with a significant part of them being consolidated at an all-union conference in Al'met'yevsk in 1971. The primary source for the development of these propositions was the most efficient methods for exploiting deposits that are widely used and have undergone practical testing in the Volga-Ural oil- and gas-producing provinces. Thus, the experience amassed during the exploitation of deposits in Tatariya, Bashkiriya, Kuybyshevskaya Oblast and other areas was correlated and used extensively.

At the same time, new decisions related to the specific nature of the local conditions and the more intensive development of the new oil production region were also developed and have been realized in practice. A list of the main propositions follows.

1. Rational Separation of Exploitational Objects

Exploitational objects for independent development with a separate network of wells are segregated on the basis of a careful study and analysis of materials on the geological structure of the deposits, the horizons' reservoir properties, the physicochemical properties of the liquids and gas, the energy characteristics of the strata, and so on. In the section on the geological structure, it is important to establish the type of deposit, the reserves, their density, and the thickness of the stratum.

In a single exploitational object, it is inadvisable to combine two productive horizons containing different types of deposits: either oil and gas-and-oil or purely oil and oil lying under bottom water, and so forth. In an independent object for development it is advisable to include a productive stratum or seam, the oil reserves of which insure such a level of extraction that exploitation of the object is economically profitable.

The productivity of the strata should be taken into consideration in the process of segregating objects. For instance, when the productivity level is high, a stratum with smaller specific oil reserves can be allocated to an independent object for development than when productivity is low. The development of such a stratum insures the necessary profitability of the oil extraction process.

In a single exploitational object it is inadvisable to include several horizons having large extractable reserves of oil. The allocation of strata to an independent object according to their thickness also depends on productivity and the final technical and economic indicators. As studies have

known, under the conditions present in Western Siberia, strata with a minimum oil-saturated thickness of about 5 m can be assigned to an independent object for development. For a gas-and-oil object or one mixed with gas, the minimum stratum thickness increases.

In addition to this, it is not recommended that horizons in which the permeability differs by a factor of two or more be combined into a single exploitational object; the formational pressure in one horizon is significantly higher than in the other, where it is close or equal to the saturation pressure; the oil's viscosities differ by a factor of more than four; the productivity of one horizon is greater than that of the other by a factor of two or more.

Thus, the first proposition had to be formulated as follows: maximum possible separation of productive horizons into independent exploitational objects in order to develop them with independent networks of operational and injection wells. In connection with this, the criterion for assigning a horizon or a large seam inside it to an independent object for development is the technical and economic indicators characterizing the profitability of extracting oil from it.

The proposition under discussion makes it possible to develop an object efficiently by insuring the necessary rate of exploitation, not subjecting part of the oil reserves to protracted conservation (which is inevitable when joint exploitation is practiced), monitor and control the development process effectively, allow for a stratum's nonuniformity and discontinuity in full measure, and obtain the maximum final oil yield.

This proposition was compiled on the basis of the available experience relating to the development of oil deposits in Western Siberia. For instance, in the early stage of their exploitation (up to 1970, approximately), for example, into a single exploitational object -- without allowing for the criteria mentioned above -- were combined and exploited by a single network of wells the BS_1, BS_{2-3} and BS_4 strata in the Ust'-Balykskoye deposit, the BS_1 and BS_{2-3} strata in the Zapadno-Surgutskoye deposit, the BS_6 and BS_7 strata in the Pravdinskoye deposit, and others. An analysis of the results of that development project showed that such a combination is inadvisable in view of the significant advance of the water front along the highly productive horizons.

Therefore, for the deposits for which the indicated decisions were made at the first stage of their development, separation of the exploitational objects during the development process was proposed and implemented. In new deposits, the exploitational objects are segregated in accordance with the proposition we have been discussing.

2. Use of Block Systems of Development of Exploitational Objects

As a rule, exploitational objects in the Western Siberian deposits are spread over considerable areas. The use of transcontour or contour

flooding systems with isolation of large independent development areas would lead to significant conservation of the oil reserves in them and to the need for a complicated and centralized equipment setup, a reduction in the deposit development rate, and considerable retardation of the formational pressure maintenance system.

For instance, when a system with transcontour flooding is used, from the very beginning of the development process it is necessary to set up equipment throughout the entire area of the deposit and build a large number of objects. In order to do this, from the beginning of development it is necessary either to expend huge amounts of equipment and material and personnel resources or to lengthen the exploitation period.

Lengthening the development period reduces the rate of increase of oil extraction. A system for maintaining formational pressure by transcontour flooding in the deposit as a whole or contour flooding with separation of the deposit into separate independent areas of development also leads to it.

When block systems are used, all these flaws are eliminated. The maximum degree of oil reserve extraction is attained in the minimum amount of time after a block is put under development. The increase in production capacity occurs smoothly and concentratedly at higher rates and the capital investments are recovered more quickly and completely.

Within the limits of a block that has been introduced, it is possible to obtain detailed information about the stratum's properties, nonuniformities and productivity more quickly, thereby enabling corrective measures and the technological development plan to be introduced on a timely basis. The use of block systems also makes it possible to shorten the period of introduction of new deposits into industrial development by a considerable amount. However, depending on the geological structure, in small deposits it is impossible to use block systems, so in them different contour and transcontour flooding systems -- or a combination of them -- are used.

The first deposits in Western Siberia (the Shaimskaya group and the Megionskoye and Ust'-Balykskoye deposits) were put into operation with transcontour flooding. Subsequently, the use of this method had to be stopped at the Megionskoye and Ust'-Balykskoye deposits because of its low efficiency and there was a complete changeover to contour flooding with additional segmentation lines and flooding nuclei.

1. Introduction From the Beginning of Development of Formational Pressure Maintenance Systems With Optimum Width of the Band of Blocks

On the basis of the geological conditions, the stratum's properties and the liquids saturating it, the width of the band of blocks must be such that the water pumped into the injection row has an active effect on the inner row of exploitation wells. Numerous studies, calculations and practical experience have shown that for the conditions existing in Western Siberia,

the width of the band of blocks is 3-4 km. No more than three-to-five rows of exploitation wells are located in it. This situation has been fully realized at all the new deposits put under development since 1970, such as Samotlorskoye, Agenskoye, Fedorovskoye and Mamontovskoye, among others.

4. Use of Optimum Well Network Densities

Based on a more thorough study of the structure of new deposits and the developmental experience gained from ones that are already being exploited, as well as the results of research, optimum well network densities have come into use since about 1970. Studies showed that for the deposits in western Siberia, the optimum networks are denser than those used in the initial stage of development there. As a result, the well network density for several deposits is now 20-30 ha/well.

5. Determining the Reserve Group of Wells Needed to Thicken the Well Network as a Function of the Planned Development System, Reservoir Properties and Nonuniformity of the Exploitational Object

Reserve group wells are drilled after the main group, not so much in order to make the basic network denser as for additional dissection of the seams inside the object and the drilling out of new zones discovered during the process of final surveying with the wells in the main group. The reserve group of wells numbers about 15 percent of the main group, as specified in the existing regulations.

6. Earliest Possible Drilling and Development, as a Rule, of the Most Carefully Surveyed and Studied Zones of a Deposit

This proposition suggests drilling into a deposit from the best known to the least known areas. For instance, if there are several high-productivity exploitational objects (or medium- or low-productivity ones), the drilling of wells begins in all of them from the very beginning of development.

7. Initial Drilling of Sectioning and Development of Rows of Injection Wells in Order to Provide for Introduction of Formational Pressure Maintenance System 1-2 Years After the Beginning of Development of an Exploitational Object

The rows of injection wells for one or two blocks are usually drilled first, followed by one, two or three rows of exploitation wells along both sides of the injection wells.

The row of injection wells is first utilized for production, with the maximum possible flow rate. When injection commences they change their function, which makes it possible to establish the most effective sectioning line in the block, and thereby insure the maximum possible coverage of the block by flooding, with respect to both area and thickness.

The realization of this proposition in all the deposits in Western Siberia has demonstrated its great effectiveness.

2. Drilling Water-and-Oil, Gas-and-Oil and Subgas Zones After the Basic [illegible] of Pure Oil Zones Has Been Drilled Into

These zones should be drilled into with well networks that are equally as dense or denser than the ones used in pure oil zones. As research done at SibNIINP has shown, for the conditions encountered in the Western Siberian oil deposits, the location of wells in a water-and-oil zone must, on the average, be limited to 4-5 m of effective oil-saturated thickness of the strata, while for a gas-and-oil zone, it must be 3-4 m.

3. In the Presence of Extensive Water-and-Oil, Gas-and-Oil and Subgas Zones in Deposits, It Is Necessary to Cut Them Off and Develop Them Independently, Taking Them in With the Basic Pure Oil Zone by Means of a Cutting Series of Injection Wells

This proposition has been realized, for example, in the Samotlorskoye deposit. For instance, along the AB_{4-5} stratum the cutting of the water-and-oil and the pure oil zones of the deposit is realized with a circular row of injection wells located approximately on the line of the inner water-and-oil contour.

Along the AB_{1-3} and B_8 strata, which have extensive gas caps, rows of injection wells intended to cut the gas-and-oil and subgas zones off from the pure oil zone were planned and are being drilled and developed. Rows of injection wells are located near the outer gas-and-oil contour when subgas oil zones are present and approximately halfway between the inner and outer gas-and-oil contours in sections where there are no such zones.

II. The Method of Multiple Drilling of Oil Deposits

This method makes it possible to drill wells at high rates, eliminate the seasonal nature of drilling work, simplify considerably the maintenance of well clusters under severe natural conditions and a high degree of swampiness, simplify the oil collection systems and increase both their reliability and the degree of automation of the entire oil extraction process, among other advantages.

As a rule, injection and exploitation wells are grouped separately, in independent clusters. The number of wells in the clusters depends on many factors, the basic one of which is the number of independent development objects in the deposit. In practice, the number of wells in a cluster can range from 4 to 20 or more.

1. In the Presence of Several Independent Exploitational Objects in a Deposit, the Drilling of All the Well Networks Is Correlated in the Plan

One network of wells is displaced relative to another by half the distance between the rows and between the wells. This makes it possible to make maximum use of a group of wells that have ceased operating on their own or jest.

12. The Introduction of New Methods for Increasing Oil Yield With a Minimum Difference in the Periods from the Beginning of the Development of an Object Using Normal Methods (Flooding, in Particular)

Such methods as enriching the injected water with surface-active substances, gas, alkali, acids and other agents are being planned and are beginning to be used in accordance with the capabilities for providing these agents at the Samotlorskoye, Zapadno-Surgutskoye, Trekhozernoye, Mamontovskoye and other deposits, although their use is most effective when it is done from the very beginning of the development process.

The injection of dry and enriched gases and water and gas mixtures has been planned for introduction in large sections of the Samotlorskoye and Vakhskoye deposits from the beginning of their development. These sections are being prepared as far as providing the necessary equipment and setting it up is concerned. Technological plans for injecting water and gas mixtures into horizons of the Samotlorskoye, Fedorovskoye and Sovetsko-Sosninskoye deposits were worked out in 1977-1978. A large section has been allocated for the conduct of intrabed wet burning in the Russkoye deposit, where the setting up of equipment began in 1978.

13. Use of Mechanized Exploitation Methods With 30-50 Percent Inundation of the Wells, and From the Very Beginning of Development in Zones, Strata or Deposits With Poor Reservoir Properties and, Consequently, Low Yield Rates

Both research and experience have shown that under the conditions present in western Siberia, wells with initial yield rates of less than 20-25 t/day must be converted to a mechanized method from the very beginning of their exploitation. Mechanized methods utilizing sucker-rod and electric deep-well pumps and gas lift are being designed and used. The most convenient and efficient one for use under the conditions encountered in the north, where it is very swampy, is gas lift, which has been introduced on a large scale in the Pravdinskoye deposit.

14. In the Second and Subsequent Stages of Development, the Creation of Flooding Nuclei, Additional Cutting or Notching Lines, and a Transition From Multirow, Linear Flooding Systems to Systems With Smaller Number of Rows (Such as From Three or Five to One) and Sometimes to Areal Flooding With the Use of Nuclear and Selective Systems

New flooding nuclei and lines are formed as the result of the drilling of new wells and the removal of old ones from operation.

7). Removal of Exploitation Wells From Operation When Their Degree of Inundation Reaches 95-98 Percent

Wells that have been removed from operational status are converted into injection wells when it is necessary to create additional flooding nuclei, or are used to exploit shallower horizons when the deposit has a multistratum structure.

The propositions that have been formulated are to some extent general ones that do not cover all the problems that must be solved when planning and analyzing the development process for a specific deposit. At the same time, the planning and practical realization of the development of oil deposits in Western Siberia is being carried out with due consideration of the propositions that have been explained.

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METHODS FOR INCREASING THE OIL YIELD OF BEDS

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[Article by M.F. Svishchev, A.I. Vashurkin, M.I. Pyatkov and V.P. Pravednikov, SibNIINP [Siberian Scientific Research Institute of the Petroleum Industry], and Yu.B. Fain, Glavtyumenneftegaz [Main Administration for Petroleum and Gas for the Tyumen' Region]: title as above]

[Text] Experience in the development of deposits that have been exploited for a long time and predictive estimates of the oil yield of the beds in western Siberian deposits both show that when standard flooding is used, a considerable part of the oil reserves remains in the ground. Therefore, it is necessary to use different methods for increasing the oil yield that insure more nearly complete extraction of the oil from the productive beds in comparison with standard flooding. This is particularly important under the conditions found in deposits in the early stage of development, when the use of new methods is most effective.

Based on the criteria of the applicability of different production processes and the results of theoretical and experimental research, with due consideration for the presence and availability of working agents and equipment, the following methods for increasing oil yield are used on industrial and experimental-industrial scales in the deposits being developed in western Siberia: transient flooding and the injection of aqueous solutions of alkali and PAV's [surface-active substance], as well as hot water. Below we discuss the state of the introduction of these methods and give the results obtained for each of them, as well as the prospects for the use of other technological processes.

Transient Flooding. As a method for regulating development that combines the cyclic injection of water with a change in the direction of the filtration flows, this has been widely used since 1975, with the volume of its use increasing every year. In 3 years, the total volume of transient flooding increased by a factor of 5.3 and totaled 175.9 million m^3, including: 1975 -- 16.7 million m^3; 1976 -- 68.5 million m^3; 1977 -- 88.7 million m^3. During the first half of 1978, 45 million m^3 of water was injected by this method. It has been used on 18 objects in 14 deposits.

Depending on the specific conditions and state of development of a deposit, the following variations of transient flooding are used: alternate [illegible] (limitation) of the pumping of water into injection wells through one well, by groups of wells, and by rows of injection wells, for a prolonged period of time.

As a result of the realization of transient flooding in the indicated volumes, there has been an increase in current oil extraction in comparison with standard flooding (for the same development rates) and equalization of the injected water front has been achieved. An additional 1.[illegible] million tons of oil have been extracted. A further increase in the volume of injected water is planned, and in 1980 it should reach 130 million m³.

Up until now this method has been introduced without any additional capital investments. It has been adapted to the existing formational pressure maintenance system, which makes the possibility of controlling the process and expanding it to the necessary volumes more difficult.

Injection of an Aqueous Solution of Alkali. This method has been used since December 1976 in an experimental section of the Trekhozernoye deposit that contains 3 injection and 19 producing wells. At the beginning of the experiment, the section was in the late stage of development. The remaining reserves of oil were about the same as the amount that had already been extracted, as confirmed by GKZ [State Commission on Mineral Resources]. The water content of the output exceeded 80 percent.

The first results of flooding with a solution of alkali indicated that the actual development indicators for the experimental section were considerably lower than the projected ones. An analysis of the operation of the producing wells showed that the alkali solution advances into the bed along a previously flushed path and does not involve the more oil-saturated zones in the development process.

In order to increase the effectiveness of this method, in September 1977 the continuous injection of an alkali solution was replaced by periodic injection of a solution and podtovarnoye [translation unknown] water, which should expand the active effect on the bed. In May 1978 the duration of the cycles of alkali solution and water injection was reduced to a minimum.

By 1 July 1979, [illegible] t of caustic soda in an [illegible] percent concentration had been pumped into the [illegible] bed of the experimental section. During the injection period, approximately 13,000 tons of additional oil were extracted. At the present time, attempts are being made to increase the effectiveness of this process.

The widespread introduction of the method of flooding with the use of a solution of alkalis is limited in Western Siberia by the fact that the surface tension of the oil in most of the deposits does not drop sharply when it comes in contact with an alkaline solution.

injection of PAV's. Since May 197[illegible], PAV's have been injected in the Samotlorskoye and Zapadno-Surgutskoye deposits, for the development of which SibNIINP and BashNIPIneft' have drawn up the appropriate technological plans.

In the Samotlorskoye deposit, PAV injection is most favorable in its northern part, where the oil pools entered the development stage comparatively recently. By 1979, about 1,300 t of PAV's had been pumped into 16 wells drilled into the AV_{2-3}, BV_8 and BV_{10} beds.

Considering the polymictic composition of the reservoirs and their large specific surface and increased moisture capacity, the injected PAV solution is prepared in a 0.1-percent concentration. Before 1980, injection wells 6, 7, 11 and 12, with a total pumping volume of 52,700 t, will also be used for PAV injection. In the Zapadno-Surgutskoye deposit, PAV's are injected in an experimental section with 23 injection and 57 producing wells. A total of 300 t of PAV's has been injected into 3 wells. It is intended to increase the injection volume to 1,230 t/yr.

In view of the brief duration of the period in which injection has been used, it would still be premature to attempt to judge its effectiveness. However, the absorptive capacity and the coverage of the bed by flooding have increased in both the Samotlorskoye and Zapadno-Surgutskoye deposits since PAV injection began.

The extensive use of PAV's to develop oil deposits is being held back because of a shortage of these substances and their high cost. Therefore, the search for and field testing of new and effective reagents for the flooding of oil beds is a matter of great practical importance.

Two reagents have been suggested and tested at SibNIINP: oxyethylated light tallovvye [translation unknown] oils (OSM) and asphalt sludge (KG). Field tests of experimental batches of these reagents in the Zapadno-Surgutskoye and Mamontovskoye deposits, in the form of short-term and extended injection of aqueous solutions, demonstrated their high effectiveness and technological qualities. For example, as a result of the injection of OSM into well 186, its response doubled for the same injection pressure ([illegible] MPa). Field geophysical investigations of the well have established that there was an increase in flooding coverage of the bed with respect to thickness. This was also confirmed by a repetition of the study after [illegible] months. Identical data were obtained as the result of the injection of KG in the Mamontovskoye deposit.

During laboratory studies of the displacement of oil by solutions of OSM and KG in the Zapadno-Surgutskoye, [illegible]-Balykskoye and Mamontovskoye deposits, a higher coefficient of displacement was achieved than with solutions of OP-10. The cost of OSM and (particularly) KG is considerably lower than that of OP-10. All of this makes it possible to count on the their widespread industrial use during the development of Western Siberia's oil deposits.

Injection of Hot Water. The experimental injection of hot water [illegible] was begun in June [illegible] in a small section of the [illegible] deposit, the oil of which is distinguished by high density and viscosity, while the amount of gas dissolved in it is low. The purpose of this injection was to determine the effectiveness of oil displacement by hot water injected from the surface, to study the dynamics of the injection well's response, and to determine the bed's filtration parameters, the time it took the water to break through into the producing wells, the nature of their flooding, and the current and final oil yield of an element.

The feasibility and scales of industrial introduction of the process will be determined from the results of the experimental injection, as well as tests of other methods and a comparative evaluation of their effectiveness.

Prospects for the Use of Different Methods for Increasing Oil Yield. An analysis of the results of theoretical and experimental investigation of the possibility of using other methods in the western Siberian deposits in the next few years shows that the most promising of these methods are the water-and-gas effect, the injection of sulfuric acid or carbon dioxide, and intrabed wet combustion.

It has been specified that the use of the water-and-gas effect on a bed will begin in the [illegible] and [illegible] deposits in [illegible]. During that year, it is intended to inject [illegible] billion m^3 of gas into them. In subsequent years this method is to be used in the Sovetskoye, [illegible], Bystrinskoye, [illegible] and other deposits. Technological plans for the use of the method have been drawn up for the first four deposits named.

The injection of sulfuric acid is planned for the [illegible], [illegible] and [illegible] deposits. Its use is effective because of the high content of aromatic hydrocarbons in the oil in these deposits. Laboratory studies of the method, as related to the conditions in these deposits, are being conducted at [illegible].

The injection of carbon dioxide is being planned for [illegible] for the [illegible], and later for the [illegible], [illegible], [illegible] and other deposits, with the [illegible] carbon dioxide being used for the production of ammonia and carbamide in a plant that is being planned for the vicinity of Surgut.

Wet intrabed combustion will be carried out in the [illegible] deposit beginning in [illegible]. It will first be used in a limited section in order to test the process's effectiveness and choose a realistic method for the development of the entire deposit.

In addition to the methods discussed above, flooding using polymer and micellar solutions may be utilized in the western Siberian deposits.

It has been recommended that the first method be tested in the [illegible] deposit, which is characterized by an increased ratio of oil and water [illegible]

viscosities. The second will be tested after the solution of problems relating to the development of the formula, technological conditions, and the organization of industrial production of micellar solutions.

In most cases, the theoretical and laboratory research and the calculations and first industrial experiments that have been performed indicated quite high efficiency for the use of the new methods for increasing the oil yield of the deposits in Western Siberia. In connection with this, we consider it necessary to see a significant expansion of the scientific research and experimental industrial work in this field and to insure an adequate supply of equipment and reagents for those doing such work.

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PLANNING THE PHYSICAL PLANT FOR DEPOSIT EXPLOITATION WITH MODELS

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No [illegible], Oct [illegible] pp [illegible]

[Article by Yu.M. Lapin, V.I. Tomanov and V.A. Aksyutenkov, Giprotyumenneftegaz: "Some Problems in the Integrated Planning of the Setting Up of Equipment at Oil Deposits"]

[Text] The unique natural conditions of the oil and gas producing regions of Western Siberia (swamps, lakes, fluvial plains, areas consisting of overmoisturized and permanently frozen ground) have a substantial influence on design and technical decisions and the construction cost and expense of operating various commercial structures.

During the development of a plan for supplying and setting up the equipment for a deposit, it is necessary to solve a large number of engineering problems having to do with determining the number of industrial structures (including motor vehicle roads and various commercial networks) and their location, as well as the technical and economic indicators for separate commercial subsystems and for the entire deposit as a whole.

The integrated nature of the planning means a joint decision on the different subsystems of the industrial setup, with due consideration for the special features of the natural conditions in the area of a deposit [1]. Such planning is related to the solution of problems of great dimensionality, the realization of which is possible only on a computer, which in turn requires the development of appropriate models of the territories.

Under the conditions we are discussing, it is practically impossible to use traditional methods of obtaining the amount of information required by the construction norms in the time allocated for the completion of the research and planning work, even for separate (determined) communication routes and construction areas. In view of this, the creation of territory models is related to the realization of the problem of collecting and processing the initial information about them (nonuniform with respect to construction conditions) and the formation of the appropriate models on the basis of this information. Research done at Giprotyumenneftegaz on an example of the solution of road planning problems makes it possible to make the following recommendations [2].

2. The model of any territory must make it possible to determine the volume of construction and installation work, material consumption, construction cost and so forth [it is also possible to take into consideration the operating expenses and harm caused by the surrounding environment that are related to the natural features at the site] per unit of length of linear communication lines or a site under areal construction at any point in the territory under discussion. In this case a point is understood to mean a geographic object in the economic-geographic definition. In accordance with the definition, we will call territorial models "models of the technical and economic indicators of territories" (MTEIT).

3. An MTEIT must contain such information about the natural conditions in the territory that the final result of the problems solved with it does not go beyond the limits of some value that is allowable at the given stage of development. From the viewpoint of both the possibility of obtaining the initial information and its subsequent realization on a computer, the representation of information applicable to certain methods of building numerical structures is realistic.

The provision of information about the natural conditions in a territory can only be done discretely. This requires the determination of characteristic points in a territory, as well as the nomenclature and corresponding volume of information at each point. As a result, there arises the need for evaluating the information from the viewpoint of its adequacy both at the given point and in the model itself, relative to the territory under discussion.

It is obvious that a model's accuracy must increase as the result of an increase in the number of points (to a certain limit) in a territory and the volume of information on each of them. However, this is advisable only up to a certain limit. In connection with this, each territory characterized by specific nonuniform features must have its own limits in view of the fact that increasing the model's information content increases its degree of similarity relative to the territory under discussion and requires an increase in the expenditure of forces and means to obtain, process, enter, store, and subsequently realize the information with a computer.

The actual solution is found between the two boundary densities of the information on a territory: the critical density, where the model is minimally informative and differs qualitatively from the actual territory, and the maximum density, where the model is maximally informative within the limits of the equipment's capabilities. Practically, it is advisable to realize the solution on the basis of the use of multilevel, hierarchical models.

Let us examine [illegible] an example of a hypothetical three-level MTEIT, as it applies to the integrated planning of the equipping and setting up of a [illegible].

First-level models are used to [illegible] general ideas for the equipping and setting up of an oil deposit and [illegible] all its territory. The volume of information required per unit of this model's area will be considerably smaller than in second- and third-level models. However, this volume is fully adequate as a basis for the realization of the fundamental planning decisions on the engineering of the [illegible] systems: the placement of the basic and auxiliary structures ([illegible] transportation [illegible], pumping stations, electric power substations, industrial bases and so on), determining the configuration of the linear structures (oil, water and gas pipelines, motor vehicle roads, electric power transmission lines) and the [illegible] technical and economic indicators of the equipping and setting up of deposits.

Second-level models are more informative than first-level ones; [illegible] part of the deposit within the limits of the principal zone (the area in which construction of industrial structures is [illegible] likely). This area is defined from the solutions of the problems on the first-level model. Second-level models are used to define more precisely the placement of the industrial objects, determining the [illegible] of the network of communication corridors and [illegible] for evaluation [illegible] other [illegible], such as [illegible] requirements, is also possible [illegible] communication links and methods of constructing them.

Third-level models, as the most informative ones, are intended for the [illegible] planning of communication line routes in the defined corridors and [illegible] the [illegible] the limits of the possible variation of the communication corridor routes or communication line routes for separate elements of the network.

The solution of the problem of creating an [illegible] for the integrated [illegible] of the equipping and setting up of oil deposits and its realization on a computer is related to the performance of research and development on the typology and classification of territories according to construction conditions, justification of the planning decisions for the construction of [illegible] structures under different natural conditions, investigation of the volumes and specific costs of the construction and installation work under different natural conditions, the modeling of territories, the construction of the [illegible].

Typology and classification of territories according to construction conditions. In the formulated problem of the construction of the [illegible], the [illegible] of the territory in the planning of [illegible] lines [illegible] and the justification of planning decisions is [illegible] and is done for the purpose of obtaining a more [illegible] of the [illegible] of the problem.

The grouping of territories is based on their [illegible] with respect to construction conditions and must be [illegible] according to the [illegible]. As such a [illegible], we [illegible], [illegible] volumes of construction and installation work on the unit of [illegible]

performing it for different construction methods. In connection with this, territories should be regarded as nonuniform if for even one of the industrial structures a construction method is found for which the function of the territory criterion differs by more than some given value.

This same principle can be used when allowing for the operating expenses related to a territory and the effect on the environment of the industrial structures that are being built. The nonuniformity criterion indicates the necessity of considering a territory's nonuniformity during planning. It is necessary to evaluate a territory's nonuniformity primarily for key sections, the substantiation and choice of which should be based on the methods of typological groupings from sampling research with the help of mathematical statistics theory.

Typological grouping means the division of a territory according to stable, differentiating qualitative indicators, and is acceptable at any problem-solving level. As an example of such subdivision we can present such categories as swamps, lakes, fluvial plains, permafrost and so on. Within the limits of the typological groupings of a territory (primarily according to qualitative indicators) their classification, which is already completely determined for each class of problem being solved, is carried out. The qualitative difference between adjacent classes basically reflects their hierarchical order -- detailing or consolidation. For instance, swamps are conditionally subdivided into types (I, II, III). The nonuniformity criterion can serve as the indicator determining the number of categories in an area (discreteness of the territory).

Such an approach will make it possible to replace the actually existing complex system of dependences of the technical and economic indicators of the construction of industrial structures on a set of arguments -- the natural conditions -- with simpler subsystems, each of which is adequately real for the corresponding class of problems being solved. As a result, there is no need for extensive differentiation of the natural conditions within the limits of an area's delineated categories, which reduces the required volume of initial information on a territory considerably.

Typification of Planning Decisions on the Construction of Industrial Structures Under Different Natural Conditions. The practice of supplying equipment for and setting up a deposit has at its disposal two methods for planning industrial structures. In individual planning, the method is based on allowing for diverse factors that either substantially or insignificantly affect the choice of the planning decision. In type planning, it is based on the grouping of factors into appropriate complexes that have a definite physical meaning and are characterized by averaged engineering decisions (for averaged natural conditions), which are represented by type plans, construction norms and so on.

The formation of an MTIPT on the basis of a given planning method is quite complicated, since it requires a large amount of initial information and the expenditure of effort and means for processing it and realizing the

details of the natural conditions. Therefore, application of planning decisions on standard construction within the delineated categories of an area, which can be done simultaneously with the classification of territories, significantly reduces the volume of initial information without substantially lowering the quality of the planning decisions. As a result, the effort is reduced sharply and is practically negligible in planning. An example of such a solution is the specification of natural conditions and planning decisions for road construction [2].

Substantiation of the volume and specific cost of construction and installation work. The classification of territories and the typification of construction design solutions make it possible to derive the appropriate [illegible] relationships for the volume of construction and installation work for the creation of industrial structures in different areal categories.

After formalizing the specific cost of carrying out the construction and installation work, which with some degree of conditionality can be divided into constant and variable groups, it is possible to evaluate the cost of construction of a structure at any point in the territory under discussion. The constant group of specific costs consists of the expenses for carrying out a unit volume of work that do not depend on the place where the construction and installation work is performed in the territory (soil removal and fill, installation of reinforced concrete and so on). The variable group consists of the expenses that depend on the place where the work is done and are basically related to the transportation of construction materials. As a result, it is possible to derive the technical and economic indicators of structural construction for every point in the territory with only insignificant expenditures of effort and means.

Modeling of territories. This can be realized with the help of analytical functions that describe the change in the parameters of the natural conditions in the area of the deposit (analytical model) or with the help of a finite set of points located in the area (discrete model). The second method is more realistic, in our opinion, since it makes it possible with less expenditure of machine time to determine the parameters of the natural conditions for the construction of industrial structures in each section of a deposit that are caused by the characteristic features of Western Siberian deposits (large area, significant — with respect to construction conditions — nonuniformity of the territory, the necessity of allowing for the characteristics of the natural conditions in each of the entire area).

Henceforth, we will call the discrete model a digital model of the area (DMA), using "area" to mean the natural conditions (areal categories) with certain essential characteristics of the area of the deposit that apply to the supplying and setting up of equipment and facilities.

More precisely, a DMA is a set of points (nodes) or "cells" in the geographical coordinate definition that are [illegible] located in the deposit's territory. Each node unambiguously corresponds to a specific part of the area (section), the natural conditions in which are defined by the

parameters given in the corresponding node. None of the sections intersect, but the area of the deposit is covered completely.

The set of possible transitions to adjacent nodes is found for each node in the TsMM. The order of arrangement of the nodes is determined by a (not necessarily regular) rectangular network, the contour lines of uniform sections of the territory, and a combination of networks and contours, and is selected on the basis of the specific deposit's natural conditions.

The TsMM is formed with the help of an algorithm for transforming the initial information on the area. The following methods of representing the initial information on an area are known: by reference points in given uniform sections (along an ordinate axis, for example) and along the boundaries of uniform sections in the area; at each node in the grid (such as the rectangular one or one consisting of equilateral triangles).

None of the indicated methods can apparently be preferred over the others, since the advantages of one are determined by the degree of nonuniformity of the territory, the shape of the uniform sections, and their distribution throughout the deposit's area. For example, for a severely nonuniform territory in which small sections with different areal categories are distributed relatively evenly, it is advisable to gather information at the nodes of a rectangular grid.

The error in modeling an area is determined by the degree of reliability of the initial information on the natural conditions at each reference point or node, as well as by the methods used to represent the initial information on the area and to construct the TsMM. The first component of the error depends on accuracy (the techniques and methods for determining the different parameters of the natural conditions), while the other two depend on the frequency of the succession of reference points along the contour lines and the spacing of the grid.

At the present time, for territories with different natural conditions we do not know precise techniques for selecting methods of representing initial information and constructing a TsMM or the frequency of the succession of reference points along the contour lines and the spacing of the grid. However, the requirements for accuracy in modeling an area are determined by the types of problems being solved, the laboriousness of obtaining the initial information on the natural conditions, and the possibilities of realizing it on a computer (basic memory volume, machine time reserves).

The feasibility of using an MTEPT in planning practice is established on the basis of how close the result obtained with the model is to the actual situation. This is determined by the adequacy of the formulation of the technical and economic indicators with respect to the model in comparison with those obtained during the setting up of the deposit for exploitation. It is obvious that the MTEPT's adequacy depends on the TsMM and the accuracy of the determination of the volume of construction and installation work and the specific cost of performing it.

Experience that has been amassed in the performance of research and planning work in the region under discussion shows that the volume of work and the specific cost of work it can be formalized quite accurately relative to the class of problems to be solved (although their effect on the [illegible] accuracy depends largely on the feasibility of detailing these calculations). The cost effect on the [illegible] is exerted by the [illegible], the initial information for which is obtained at points in the area that are located throughout the territory in a certain manner.

To us, the most complicated question is that of the density of the points and the mode of assigning them throughout the territory, both of which depend on the reliability of the information obtained at a point itself, the nonuniformity of the territory, the expenditure of effort and means required to obtain the initial information, and the class of problems under discussion. This problem can be solved by two methods: by means of experience and by effective formalization using the appropriate mathematical apparatus. In the near future, the method of experimental evaluation by means of solving problems in conformity with [illegible] with different density and modes of assignment of the points in a territory should become applicable in practice.

Construction of the [illegible]. After the [illegible] is obtained, the [illegible] is formulated. In connection with this, every point in the model is described by a group of functions that make it possible to derive technical and economic indicators for different methods of constructing the industrial structures.

In general, the practical problem of creating such an [illegible] (at different levels) can be solved in the following sequence:

1. Determine the size and configuration of the deposit area that must be set in the exploitation operations.

2. Carry out aerial or engineering surveying work, and [illegible] the key positions of the territory.

3. Conduct a [illegible] consolidation of the [illegible] and [illegible] the territory.

4. Construct the [illegible].

5. Formalize the volume of work and its specific cost relating to [illegible] methods for erecting industrial structures.

6. Determine the [illegible] in the deposit for the transportation of the different construction materials.

7. Solve the problem of [illegible] the deposit in the exploitation of the [illegible]. The [illegible] of solution of which are set [illegible] in this article.

Before determining the effectiveness of using an MTIPT, in the solution of problems having to do with setting Western Siberian oil deposits, it is advisable to discuss the special features of the selection of the basic planning decisions. Many of them are made for conditions that are not encountered in practice not only in the organization of deposit exploitation, but in the construction of other branches of the national economy. Decisions are frequently made not only in the absence of a sufficient volume of information, but also on the basis of indeterminate information.

As a rule, the decision-making process is allocated only a small amount of time that is inadequate when the multivariant approach to planning decisions is used (the working drawings are frequently developed before the plan for the technical and economic substantiation of the project). Decisions are made under conditions where many of the organizational questions are poorly or even not formalized, as a result of which the final decision depends largely on the planner's experience (or intuition).

The use of an MTIPT during the solution of problems having to do with the integrated organization of the physical setup for exploiting deposits will contribute to a minimization of the expenditures needed to complete the setup, since it makes it possible to allow for nonuniformity of the territory with respect to the conditions for constructing different industrial structures in it, as well as to a better substantiated choice of the strategy for carrying out the investigative planning work.

Having such an apparatus at hand, the planner can implement the following measures.

1. Determine the prospective (by "testing" with models) planning decisions and directions for further investigations into the improvement of engineering design developments in separate fields of the physical preparation of deposits for exploitation.

2. Methodically and more substantiatedly approach the allotment of work volumes during surveying by having answered the question of the necessary and sufficient information content relative to the class of problems being solved.

3. Reduce the expenditure of efforts and means in surveying and planning work as the result of extensive and unified typification of natural conditions as they apply to the problems of the industrial setup.

4. Develop principles for the creation of automated planning systems based on formalization of the natural conditions and engineering design decisions.

5. Contribute to ensuring a high degree of practicality in the decision-making process and, by producing graphic final results, simultaneously increase the confidence in them (since the planner will participate in the logical and mathematical procedure of making the decision).

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CHEMICAL CHANGES IN INJECTED WATER USED FOR FLOODING DISCUSSED

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[Article by M.Yu. Tumova, L.S. Novikova and G.M. Gvozdeva, SibNIINP [Siberian Scientific Research Institute of the Petroleum Industry]: "Features of the Change in Water Composition During the Flooding of Oil Pools"]

[Text] The development of the multistrata oil deposits of Western Siberia has special features related to the flooding process that are determined by a number of specific properties inherent in the reservoirs and the liquids with which they are saturated:

1. The polymictic composition of the reservoirs in most of the productive beds (except for the Shaim region) and, in connection with this, the comparatively poor reservoir properties and unusually high content of bound water (from 20 to 40-45 percent).

2. Low mineralization (15-28 g/l) and a monotypical composition of the waters. As far as these indicators are concerned, the different productive beds in a single deposit differ insubstantially. The waters in most of the productive beds belong to the calcium chloride type, and only in individual cases -- primarily in the lower part of the profile -- are sodium hydrocarbonate waters encountered.

Yet another special feature of the development of the Western Siberian oil deposits is the use of intensive flooding systems from the beginning of exploitation of the pools.

Subterranean water from the Aptian-Albian-Cenomanian complex, which differs little from the stratal waters of the productive beds in both total mineralization ([illegible] g/l) and type (calcium chloride), is used for the PPD [formational pressure maintenance] system during the initial period in most deposits.

Subsequently, the Aptian-Albian-Cenomanian water is either partially or completely replaced by fresh and podtovarnaya [translation unknown] water. In individual cases fresh water is used from the beginning of the development process. The presence of contiguous productive beds and the use of

Table

[illegible]

(Key following next page)

[illegible]											
Ca^{++}	Mg^{++}	$Na^{+} + K^{+}$	K^{+}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]											
[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Key to Table 1:

1. Bed
2. Density, g/cm^3
3. Mineralization, g/ℓ
4. Content, mg/ℓ
5. (mg/ℓ)/(mg-equiv/ℓ)
6. Ust'-Balykskoye deposit
7. B
8. Aptian-Albian-Cenomanian
9. Absent
10. Al
11. Br
12. Traces
13. Fedorovskoye deposit
14. Mamontovskoye deposit
15. Zapadno-Surgutskoye deposit
16. Samotlorskoye deposit
17. Note: The values in the numerators are given in mg/ℓ, those in the denominators in mg-equiv/ℓ.

The joint exploitation of two or three pools makes monitoring the extraction of the oil and (particularly) the flooding source considerably more difficult. In most cases, however, the individual micro- and macrocomponents and the combinations of them can be used for a confident differentiation of the stratal waters both from each other and from the injected Aptian-Albian-Cenomanian waters (Table 1) [1-4]. This made it possible to simplify the monitoring of the development process in the presence of accidental breakthroughs of the waters (overflows beyond the column, the appearance of water because of a lack of watertightness in the column).

A study of the chemical composition of waters extracted as by-products showed that when contour or bottom water is drawn up and loosely bound (pellicular and even injected, when the well is near) waters are in motion, the source of the inundation cannot be established precisely. This is explained by the fact that when they move along a bed, injected waters interact with the oil, rock and bound water, which can disrupt the physicochemical equilibrium that has been established in the bed. As a result of this, the precipitation of mineral salts has been noted in deposits where fresh water was injected in the well and other industrial equipment. In wells inundated with stratal (contour or bottom) waters, salt deposition was observed in rare cases only.

Experiments were performed under laboratory conditions in order to study the possible change in the chemical composition of injected water as it passes along an oil-saturated bed. Stratal, fresh and Aptian-Albian-Cenomanian waters were mixed with oil from different deposits (Samotlorskoye, Ust'-Balykskoye, Tetorevo-Mortym'inskoye) in the first series of experiments. In connection with this it was established that no substantial change takes place in the composition of the waters, since the oil contains only a small amount of mineral salts in the form of suspended drops of mineralized water.

In the second series of experiments, the interaction of different waters with rock was studied [2,3]. The mixing of different types of water with crushed rock showed that two processes take place in connection with this: 1) the passing into solution of not only easily dissolved salts (NaCl), but also of calcium and silicon carbonates and SO_4^{2-}, and 2) an exchange between the ions in the water and the rock.

Table 7.

Indicators (1)	Values of indicators for different ratios of mixed waters (2)											
	Cenomanian + stratal (3)			Podtovarnaya + stratal (4)			Podtovarnaya + fresh (5)			Podtovarnaya + fresh + stratal (6)		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
pH: immediately after mixing (7); after 1 day (8)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{2+} immediately after mixing (7): mg/l (9); mg-equiv/l (10)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ca^{2+} after 1 day (8): mg/l (9); mg-equiv/l (10)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Key:

1. Indicators
2. Values of indicators for different ratios of mixed waters
3. Cenomanian + stratal
4. Podtovarnaya + stratal
5. Podtovarnaya + fresh
6. Podtovarnaya + fresh + stratal
7. Immediately after mixing
8. After 1 day
9. mg/l
10. mg-equiv/l

The dissolution [illegible] process predominates during filtering, but after [illegible] the mineralization of the water [illegible] increased [illegible] 1500-1700 mg/l. These experiments were then supplemented by others under [illegible] conditions. The waters were filtered through core samples under a pressure and at a temperature equal to those in the bed. Here as well, the change in the chemical composition of the filtered waters confirmed the results of the preceding experiments.

The only unusual thing noted was that the mineralization of the first portion of filtered water was somewhat increased, which is explained by the dissolution of the bound water in the core. A similar phenomenon is observed during the operation of wells inundated with injected water. The front of [illegible] water reaches a well; it [illegible] with the bound water that is there. When production begins, the [illegible] of these waters takes place; a margin of water with a composition that is the same as that of the bound water forms on the injection front.

As far as their composition and total mineralization are concerned, these waters are not distinguishable from stratal waters for all practical purposes. Only in individual cases has their slightly increased (by 2-3 g/l) mineralization, with retention of the percentage relationship of the basic components, been registered.

In the last series of experiments, the processes taking place in a bed in connection with the mixing of stratal waters with injected ones, in varying volumetric ratios, were investigated (Table 2). These experiments show that the use of fresh water for a PPD system disrupts the carbonate equilibrium and leads to the precipitation of calcium carbonate.

Conclusions

1. When passing through a water-saturated bed, injected waters interact with the oil, the rock, and the bound water.

2. During the interaction, the injected waters are enriched with carbonate, chlorine and CO_2 as the result of [illegible] from the bed. Ion exchange, natural filtration and chemical interaction take place.

3. These phenomena take place most intensively when fresh water is injected into a bed. The result of this is the precipitation of mineral salts in the well and other [illegible] equipment. Metal corrosion is also observed as the result of the appearance of sulfides in the water.

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UDC 622.276.56

NEW METHOD OF REGULATING DEPOSIT DEVELOPMENT EXPLAINED

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 77 pp 39-41

[Article by A.N. Yanin, SibNIINP [Siberian Scientific Research Institute of the Petroleum Industry]: "Effectiveness of Regulating Deposit Development with the Help of Diamond Wells"]

[Text] One of the most effective measures used to regulate the development of oil deposits is the drilling of additional wells after the basic group has been put into operation [1]. Let us examine the results obtained by using this method in the Ust'-Balykskoye deposit, where a large number of additional wells were drilled.

The basic exploitational object in the deposit is the BS_1, BS_{2-3}, BS_4 and BS_5 beds. According to their geological structure and nonuniformity parameters, they can be regarded as comparatively uniform and sustained with respect to both area and thickness, with their ruggedness factor being 1.6–2.9. The arenosity factor of the BS_1, BS_{2-3} and BS_4 beds ranges from 0.83 to 0.87, while for the BS_5 bed it is 0.67. With respect to the brokenness parameter k_{g}, which determines the coefficient of pool coverage by an effect, the BS_1, BS_{2-3} and BS_4 beds are characterized as slightly broken, with k_g values of 0.25, 0.32 and 0.37, respectively, while for the BS_5 bed it is 0.62 [2].

Industrial exploitation of the Ust'-Balykskoye deposit began in 1964 and the maximum oil extraction level was reached in the eighth year of exploitation. At that time the average annual water content of the oil was 11.3 percent.

Initially the basic productive beds (BS_1, BS_{2-3} and BS_4) were drilled into with a single network of wells. (The BS_5 bed was developed later, with an independent network). The arrangement of the rows parallel to the oil pool outline (rather than to the axial sectioning row) that was specified in the engineering plan resulted in a situation where the distance from the first production row to the axial row turned out to be different. Within the limits of the oil-bearing section, on both sides of the axial sectioning row, there were four, three and two rows of producing wells, respectively, for the BS_1, BS_{2-3} and BS_4 beds.

Figure 1. Dynamics of indicators for the basic, additional and total groups of wells: Q_{ob}, Q_o = oil extraction with the basic and total well groups, respectively; $Q_o - Q_{ob}$ = oil extraction by the additional group; Q_{lb}, ΣQ_l = liquid extraction by the basic and total well groups, respectively; $\Sigma Q_l - Q_{lb}$ = liquid extraction by the additional wells; η_{wb}, η_{wa} = average annual water content for the basic and additional well groups, respectively; N_b, N_a = basic and additional groups of producing wells, respectively; q_{ob}, q_{oa} = average daily oil yield for the basic and additional well groups; q_{lb}, q_{la} = average daily liquid yield for the basic and additional well groups, respectively.

Thus, the pool in the Ust'-Balykskoye deposit was affected by both axial and transcontour flooding. The width of the band occupied by the producing rows on each side of the axial row was greater for the BS_1 bed than the BS_{2-3} bed by an average factor of 1.5. In the northern section of the BS_1 bed's pool, the wells were arranged in a linear, three-row system parallel to the northern (Solkinskiy) sectioning row. This is a unique section, with a geometrically correct well placement system.

In 1970, which was still prior to the completion of the drilling of the basic group, drilling of the reserve group (75 wells) began. In connection with this, oil extraction was at 86 percent of its maximum level; its water content was 7.7 percent. From 1970 to 1975 the reserve group, which was specified in the original engineering plan, was used completely, and 1976 saw the beginning of the drilling of the blanketing network of wells recommended in the areal development plan of 1975.

The reasons for this were as follows: the necessity of eliminating the considerable lag in the rates of development of the BS_{2-3} bed (which was allowed during the initial period) in order to bring it up to the planned maximum extraction level (1970-1972); intensification of the development process at the stage of maximum oil yield from the object in order to maintain the oil production level attained in 1972; the separation of beds that were previously exploited jointly into independent objects for development in order to insure more flexible and effective development of each bed; increasing the final oil yield factor; replacement of a small number of wells that went out of operation for technical reasons.

Before the maximum oil yield level was achieved, the following numbers of producing wells were drilled: BS_1 — 7, BS_{2-3} — 24, BS_4 — 5. In all, 191 reserve (according to the engineering plan) and blanketing (according

Table 1.

Well group (1)	(2)	Well network density (relative) (3)	
		Without injection wells (4)	With injection wells (5)
Planned (6)	[illegible]	[illegible]	[illegible]
Planned (7)	[illegible]	[illegible]	[illegible]
Supplemented (8)	1976	[illegible]	[illegible]
Supplemented (9)	[illegible]	[illegible]	[illegible]

Key:
1. Well group
2. Year of completion of drilling
3. Well network density (relative)
4. Without injection wells
5. With injection wells
6. Basic
7. Basic and reserve
8. Actual
9. Cumulative

to the development plan) were drilled from 1970 to 1977, including 186 producing and 51 injection (of which 22 were temporarily operational) wells. The dynamics of the indicators for the well groups are presented in Figure 1. Data on the average relative density of the well network, as calculated for the cumulative number of wells drilled within the limits of the inner oil pool outline, are presented in Table 1.

From Table 1 it is obvious that after all the additional wells are drilled, the network's density will double in comparison with the density that was originally planned.

By the beginning of the drilling of the additional wells, the injected water front had advanced approximately by 700 m along the $Bš_1$ bed and 450 m along the $Bš_{2-3}$ bed. At the beginning of the development of the pools, its average rate of advance was more than 230 m/yr in the $Bš_1$ bed and about 190 m/yr in the $Bš_{2-3}$ bed. Under these conditions, the drilling of additional wells in the band between the axial and first producing rows would have been unjustified. Therefore, in 1970-1972 a small number of planned wells were situated in this zone, primarily in the sections of the $Bš_{2-3}$ bed where the water's rate of advance was low.

Subsequently, wells were drilled mainly in the inner rows. By the beginning of the drilling of the blanketing wells specified in the development plan, the injected water had advanced from the axial injection row an average of 1,700-1,900 m along the $Bš_1$ bed and 1,400-1,600 m along the $Bš_{2-3}$ bed. At the same time, the outer rows of producing wells for these pools were inundated with contour water. Therefore, 60-65 percent of the new wells were drilled in the zone adjacent to the second and third rows, which under the conditions of comparatively uniform and sustained beds should obviously be regarded as the most advisable location. In connection with this, the oil yield will not be reduced substantially and the operating conditions for the new wells will prove to be more favorable.

The thickening of the original network of wells in the complex, along with other measures for regulating the development that were instituted, made it possible to achieve a substantial retardation of the rate of decrease in the oil yield during the medium water content (50-75 percent) stage. After a small drop in the extraction level in 1973-1974 that was caused by the absence of the introduction of any new wells, the drilling of additional

Table 2.

(1)	(2)									
(3)										
(4)	107	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(5)	1.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(6)										
(4)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(5)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(7)										
(4)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(5)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(8)										
(4)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(5)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(9)										
(4)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(5)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(10)										
(4)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(5)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Key:

1. Indicators
2. Development years
3. Oil extraction, percent of total, by well group
4. Basic
5. [illegible]
6. Liquid extraction, percent of total, by well group
7. Number of producing wells, percent of total group, by well group
8. Oil yield, t/day, by well group
9. Liquid yield, t/day, by well group
10. Water content of wells, percent, by well group

wells in 1976-1977 made it possible to stabilize the level of oil extraction at about 5.4-5.6 million t/yr. By the end of 1977, the water content of the wells was 87.5 percent.

The percentage of oil extracted by the additional wells increased in direct proportion to the number of wells in that group (Table 2), and in 1975, 1976 and 1977 was 35.5, 41.2 and 57.5 percent, respectively, of the total oil extracted from the object. The data in Table 2 are indicative of the high degree of effectiveness of the regulation of the Ust'-Balykskoye area's development by the drilling of new wells. For example, the total production of oil per additional well introduced in the 1970-1977 period averaged 171,000 t (at the beginning of 1978).

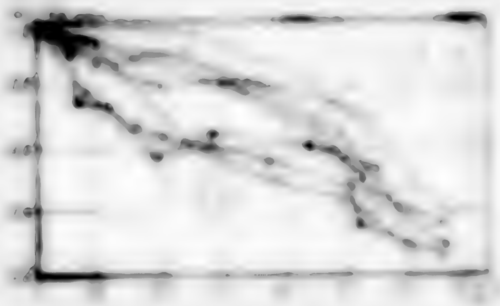

Figure 2. Dependence of oil yield on water content: $q_{н}$ = annual oil yield, $q_{н\,max}$ = maximum annual oil yield; $\bar{n}_{в}$ = average annual water content. 1,2,3,4,5,6,7,8 = year of introduction of wells into operation (1967, 1968, 1969, 1970, 1971, 1972, 1973 and 1975, respectively).

A significant part of the newly introduced wells are converted to the mechanized extraction method in their first or second year of operation. The use of high-productivity pumps makes it possible to draw off large volumes of liquid (200-220 t/day per well). Of the wells put into operation in 1976, 1977 and the first half of 1978, as 1 September 1978 more than 80 percent were equipped with pumps, while in the old (basic) group the number of wells so equipped did not exceed 50 percent.

Table 3

Indicators (1)	Year of introduction of wells into operation (2)	
	1976	1977
Average water content during first year of operation, % (3)	[illegible]	[illegible]
Percentage of wells flooded during first year of operation (4)	[illegible]	[illegible]
Cumulative water-oil factor on 1 September 1978 (5)	[illegible]	[illegible]
Average flow rate, t/day (6)		
Oil (7)	[illegible]	[illegible]
Liquid (8)	[illegible]	[illegible]
Average water content for the period January-August 1978, % (9)	[illegible]	[illegible]

Key:
1. Indicators
2. Year of introduction of wells into operation
3. Average water content during first year of operation, %
4. Percentage of wells flooded during first year of operation
5. Cumulative water-oil factor on 1 September 1978
6. Average flow rate, t/day
7. Oil
8. Liquid
9. Average water content for the period January-August 1978, %

For 1970-1977 the average oil yield of the bigmeeting wells was [illegible] t/day, while for those in the basic group it was [illegible] t/day. As a result of this, the relative annual extraction of oil from the new wells, expressed in terms of the maximum extraction of oil for each annually introduced group of wells, exceeds this indicator for the old group by a factor of 1.3[illegible] for the same water content (Figure 2) and is particularly noticeable when the water content is 50 percent or less (as the water content increases, the difference gets smaller).

Despite the high initial flow rates of oil from the [illegible] wells, their yield decreases in time as the result of intensive flooding. Because of the [illegible] of the oil-bearing area, the conditions for operating new wells have deteriorated, particularly during the late period of 1976 and 1977 (see Table 3).

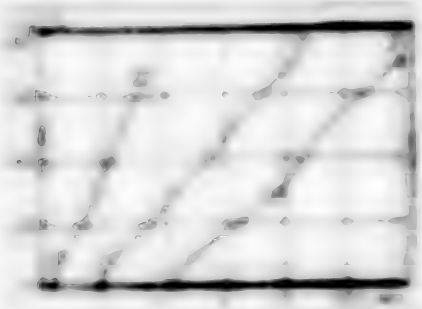

Figure 3. Dynamics of flooding of three groups of wells put into operation at different times: q_w = = average annual water content

For example, of 91 wells put into operation in 1976, 27 were flooded by the end of that year and 41 were by the end of 1977. The average annual water content of wells in the basic group was 64.9 percent in 1977, while for the additional group it was [illegible] percent. The flooding of the new wells is characterized by a rapid decrease in the percentage of oil in the extracted liquid.

In order to determine the features of the flooding of the different categories of wells, they were divided into three groups according to the time they were put into operation: I — 1957-1968, II — 1969-1976, III — 1971-1977. The average amount of time from the moment a well was put into operation until the onset of flooding at the 10, 20, 30 percent level and so on was calculated for each group. As a result of this, the regularity of the flooding of the groups of wells drilled at different times was revealed (Figure 3).

For example, for Group I the waterless period averaged 6 years, for Group II it was about 3 years, and for Group III — less than half a year. The Group I wells were 50-percent flooded in [illegible] years, while for Groups II and III the figures were [illegible] and [illegible] years, respectively. After the factual data were processed by the method of least squares, equations were derived that can be used to calculate the amount of time required for the flooding of each group of wells to reach a given level:

[illegible] (1)

[illegible] (2)

[illegible] (3)

where T — time from the moment of introduction of the wells into operation, in years.

The values of the slope in these equations show that the intensity of the flooding of Group III wells is greater than that of Group II wells by a factor of [illegible] and Group I wells by a factor of [illegible].

The shortening of the waterless period and the higher rate of flooding of the new wells lead to a situation where the water-oil factor for Group III ([illegible]), as calculated cumulatively during the time of operation, is higher than for Groups I and II ([illegible] and [illegible], respectively). The comparatively small difference in the water-oil factor for the different groups indicates that the areal flooding of the pools in the exploitational object is uniform. Field geophysical studies conducted in newly drilled wells show that the [illegible] beds are worked unevenly with respect to thickness. Basically, the reserves in the lower and middle parts of the profile are worked first.

By 1976, the degree of flooding of wells in the Ust'-Balykskoye area was more than 75 percent. The pools in the [illegible] beds were almost completely flooded and only separate isolated sections remained saturated with oil. In August 1976, waterless oil was obtained from only seven wells. Under these conditions, the drilling of additional wells will be less effective than it was in 1970-1977.

In view of this, the locations of the remaining additional wells from the planned number should be chosen on the basis of a careful analysis of technological, geological and geophysical data. Primarily, additional injection wells will be drilled in transverse rows for more efficient regulation of the exploitation of the reserves in the heavily flooded pools.

Conclusions

1. The drilling of additional wells in the Ust'-Balykskoye area made it possible to raise the oil yield of the [illegible] and [illegible] beds to the projected maximum rates (1970-1972) and maintain them at this level during the period 1972-1977.

2. The operation of the additional wells was characterized by high indicator values, with the oil produced by them in 1977 being more than half the total amount extracted.

3. The drilling of alternating and reserve wells made it possible to change from the combined exploitation of beds to the development of each bed with an independent network of wells, for the more efficient regulation of the exploitation of the reserves from the flooded pools.

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UDC 622.276.43

INJECTION OF COLD WATER INTO THE SAMOTLORSKOYE DEPOSIT DISCUSSED

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 43-46

[Article by A.R. Tsybul'ko, SibNIINP [Siberian Scientific Research Institute of the Petroleum Industry]: "Effect of Injecting Cold Water on the Development of the Samotlorskoye Deposit"]

[Text] In connection with the high current flow rates in the Samotlorskoye deposit, a huge amount of water from surface sources is being pumped into the oil-bearing beds. Because of the climatic conditions, the injected water has an average annual temperature at the well mouth of 5-7°C, which is considerably lower than the bed temperatures in this deposit (60-80°C). By a calculative method [1] it has been established that in connection with the industrial geological conditions existing in the deposit, the injected water arrives at the well bottom at a low temperature that is practically equal to its temperature at the mouth because of the comparatively short period of time that elapses after its injection (less than a month).

However, the injection into the beds of large amounts of water that has a low temperature at the well bottom leads to the formation of cooled oil-saturated zones that can have a negative effect on the development of the beds. It is the case, however, that such zones will appear only in the presence of an outstripping advance of water along one of the adjacent horizons (beds, intercalations) when the clayey areas separating them are thin [2].

The outstripping advance of water in the deposit under discussion is caused by the following factors: 1) the complexity of the geological structure (the average coefficient of dismemberment of its five horizons is 6.4); 2) increased bedding nonuniformity (the average permeabilities for the individual beds range from $5\cdot10^{-15}$ to $1,300\cdot10^{-15}$ m^2 and significant microuniformity is seen); 3) the presence of extensive water-and-oil zones occupying 30-80 percent of the total oil-saturated area; 4) initial development of the most productive sections of the individual horizons; 5) the existence of independent networks of wells in each of the horizons; 6) the remoteness of the well bottoms of the nearest injection rows from the adjacent horizons (a horizontal distance of 200 m or more); 7) incomplete coverage by flooding of the oil-saturated strata in the injection wells.

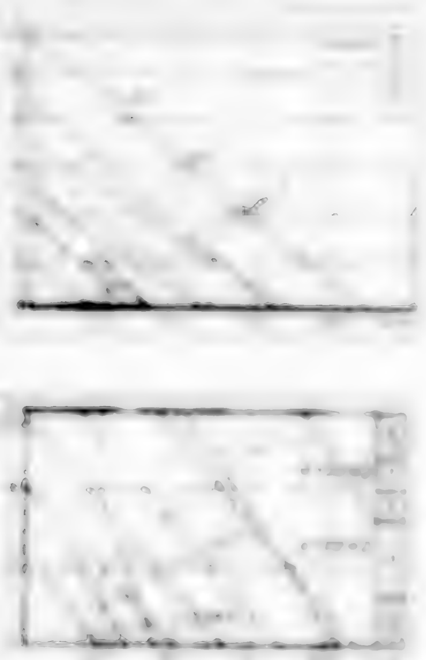

Figure 1. Temperature fields in beds of the BV_0 and AV groups in the area of the injection wells for respective durations of surface water injection of 1 (I), 3 (II) and 5 (III) years. a. wells 4729–4739. 1, 2, 3 = location of 20, 30, 40°C isotherms, respectively, in the rocks surrounding the BV_0^{1-2} bed (z_1 = 0 = top of BV_0^{1-2} bed); b. well 1523. 1', 2', 3' = the same, for rocks surrounding a high-permeability intercalation (z_1 = 0 = top of the intercalation, k = 600·10^{-15} m^2). 4, 5 = for clays and sandstone, respectively.

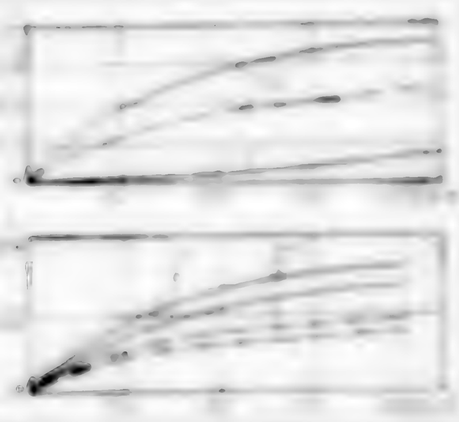

Figure 2. Fields of saturation with mobile oil in beds of the BV_0 and AV groups in the area of the injection wells for respective durations of surface water injection of 1 (I) and 3 (II) years. a. wells 4729–4739. 1', 2' = saturation in beds BV_0^{1-2} and BV_0^{3}, respectively; b. well 1523. 1', 2' = the same, in low-permeability intercalations of 80·10^{-15} and 30·10^{-15} m^2, respectively.

The presence of thin (1.5–3.0 m for the group of AV beds, for example), clayey interlayers that separate adjacent horizons, beds and intercalations is characteristic of the Samotlorskoye deposit.

Figures 1 and 2 depict instances of the formation of cooled, oil-saturated zones in two typical sections of this deposit, the industrial geological characteristics of which are presented in Table 1.

N.A. Lavernel's calculative method [3] was used to plot the temperature fields (Figures 1a, 1b), while the calculative techniques presented in [4] were used to plot the fields of saturation with mobile oil (σ') beyond the displacement front (see Figures 2a, 2b). In the calculations, the filtration rates (v) for the BV_0 horizon were chosen according to the average flow rate for the injection wells and the results of field investigations of the injected water's distribution with respect to the beds, while for the intercalations of the AV_1 bed they were chosen according to the average injection rate and the rate of their permeabilities k. The thermal

Table 1.

(1)	(2)	(3)	(4)	(5)	(6)				
					(7)	(8)	(9)		
BB (10)	[illegible]	[illegible]	BB, BB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AB (11)	[illegible]	[illegible]	AB	1, 2, 3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Key:

1. Horizon
2. Number of injection wells in the section
3. Average flow rate per well, m^3/day
4. Bed
5. Intercalation No.
6. Thickness of clayey interlayers, m
7. Minimum
8. Maximum
9. Average
10. BV
11. AV

capacity of the flooded beds and the rock surrounding them was taken to be [illegible] $J/m^3 \cdot °C$, while the temperature of the water at the bottom of the injection wells was 5°C [1].

From a comparison of the temperature fields (see Figures 1a, 1b), the saturations with mobile oil beyond the displacement front (see Figures 2a, 2b), and the thicknesses of the clayey interlayers between the high- and low-permeability beds (intercalations, see Table 1), the following conclusions can be drawn: 1) in the sections under discussion, large bed volumes are cooled when surface water is injected; 2) cooled, oil-saturated zones with a considerable mobile oil content form in the low-permeability BV_8 bed and AV bed's intercalations because of the thermal conductivity of the adjacent high-permeability beds; 3) in the case of the comparative uniformity of the BV_8 bed and the absence of a thermal effect from the other beds, practically no mobile oil remains in the cooled zones because of the great lag of the cooling front behind the displacement front.

For instance, the 40°C isotherm in the low-permeability BV_8 bed (see Figure 1a) and bed intercalations with [illegible] (see Figure 1b) will move away from the injection wells by distances of 125, 65 and 85 m, respectively, in 3 years. In the zones cooled to this temperature, 35, 31 and 20 percent, respectively, of the mobile oil will remain. However, in the zone in the BV_8 bed that is cooled to 40°C or lower, less than 1 percent of the mobile oil will remain.

When a low-permeability bed (intercalation) turns out not to be involved in the development process for any reason whatsoever, the volume of cooled mobile oil will increase significantly.

The structure and conditions for the development of the rather large volume of the sections in the Samotlorskoye deposit that are being developed are close to those of the sections under discussion. Consequently, the conclusion about the presence and size of the cooled, oil-saturated zones can be extended to them. Using the results of the calculations that have been made (see Figures 1a, 2a), it is also possible to assume that there are significant cooled volumes of mobile oil that form in sections of the water-and-oil zones because of the special deposit exploitation features mentioned above.

The significant cooling of the oil beds in some sections of the Samotlorskoye deposit and, consequently, the possibility of the formation of cooled, oil-saturated zones have been confirmed by field temperature measurements made by SibNIINP and the Tyumenneftegeofizika trust. The basic thermometric investigations were performed in the higher-lying, flooded, nonperforated beds, using injection and exploitation wells that were operating on lower-lying horizons but were temporarily out of service. Since the prefilter zone in these wells had been cooled (or heated) by the injection of cold water (or the extraction of hot liquid), the temperature anomalies measured for the nonperforated higher-lying beds (caused by the movement of liquid along this bed) can serve only as a qualitative indicator of the presence of cooling.

Unfortunately, there are very few temperature measurements from control piezometric wells and from ones that have been standing idle for a long time. In view of the fact that the temperature was measured at a distance of 250 m or more from the injection wells, while the time intervals between the measurements and the initiation of operation of the nearby injection wells were comparatively short (1-2 years), cooling was not detected in all of the wells that were studied (21 out of 45). Table 1 shows the results of the measurements for the wells in which the temperature anomalies exceed 2°C. From an examination of the figures it is obvious that in some sections of the AV_{4-5} (bed temperature = 60°C) and the BV_8 (bed temperature = 72°C) horizons, the temperature of the bed drops at a considerable distance from the injection wells.

Under the conditions present in an oil bed, the presence of cooled, oil-saturated zones can lead to a reduction in the enveloping of the bed by flooding, because of crystallization of the paraffin in the oil and a reduction in the final displacement factor, and, consequently, to a reduction in the oil yield.

By experiments performed on natural formations of a porous medium (l = 0.15-0.18 m, D = 0.036 m, $k = 62 \cdot 10^{-12}-316 \cdot 10^{-12}$ m^2), using a model of the oil from the Samotlorskoye deposit (degasified oil + kerosene) with viscosity close to that of the bed oil (1.1-1.4 mPa·s), from this deposit, it has been established that the final displacement factor increases as the temperature does. For a change in temperature from 22 to 70°C, the maximum increase in the final displacement factor is 11-12.5 percent.

Table 2

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
[illegible]	[illegible]	[illegible]	[illegible] (11)	[illegible]	[illegible]	[illegible] (12)	[illegible]
[illegible]		(10)	[illegible]	[illegible]	[illegible]	[illegible] (13)	(12)
[illegible]	(9)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible] (14)		[illegible]	[illegible]	[illegible] (15)	[illegible]
		[illegible] (16)		[illegible]	[illegible]	[illegible] (17)	[illegible]
[illegible]	[illegible]	[illegible] (14)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(10)	[illegible]	[illegible]	[illegible]	[illegible]	(15)	[illegible]
[illegible]		[illegible] (18)		[illegible]	[illegible]	[illegible] (17)	[illegible]
	(14)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] (15)	[illegible]
		[illegible] (10)	[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	(14)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] (17)	[illegible]
[illegible]		[illegible] (18)		[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	(14)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible] (10)	[illegible]	[illegible]	[illegible]	(12)	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible] (13)	[illegible]
[illegible]	(14)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] (15)	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] (19) [illegible]

Key:

1. Well No.
2. Investigated horizon
3. Status of well before investigation
4. Bed
5. Amount injected on date of investigation, $m^3 \times 10^3$
6. Time between beginning of injection and beginning of investigation, months
7. Conditions of investigation
8. Reduction in temperature, °C
9. A_1
10. Injection
11. B_1
12. Stopped after ... hrs
13. Ditto
14. Exploitation
15. Stopped
16. Control
17. Idle
18. Standing idle
19. Note: well [illegible] was exploitational from February 1973 and a control well from July 1974

The conditions for precipitation of the paraffin in deep samples of the oil were investigated at VNII (All-Union Scientific Research Institute of Petroleum and Gas) for only one well in the BV_8 horizon. It was determined that the paraffin saturation temperature of the oil, given the former's concentration in the oils of the Samotlorskove deposit (2.5-3 mass %), is 24-27°C.

From the results of the calculations that have been made (see Figures 1 and 2), the field temperature measurements (see Table 2), and laboratory research, it can be concluded that for the Samotlorskove deposit, a reduction in the beds' oil yield is possible because of the reduction in the

[illegible] of the reduction in [illegible] the oil with paraffin.

In [3] the author discusses the process of natural recovery of the tempera-ture in the [illegible] after the cessation of surface water injection. [illegible]
1. Separate injection of water into large intervals [illegible]
2. [illegible]
3. [illegible]
4. Thermal treatment of the bed zones near the well bottoms in order to increase their coverage with respect to thickness.

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4. [illegible] "Calculating the Distribution [illegible]

5. [illegible] Temperature Recovery [illegible]

[illegible]

UDC 622.276.53.[illegible]

IMPROVING THE OPERATIONAL EFFICIENCY OF PUMPING WELLS

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 49-51

[Article by V.A. Afanas'yev, A.A. Reznik and L.I. Chirikov, SibNIINP [Siberian Scientific Research Institute of the Petroleum Industry]: "Title as above"]

[Text] In the oil fields of Western Siberia, almost 80 percent of the stock of mechanized wells is operated by the pump method. As the fields are developed further, this group will grow continually and in the future should number some 11,000 wells.

Basically, the group of pumping wells is equipped with Soviet-designed centrifugal electric pump units (UETsN) and a few imported type sizes. The borehole-pump wells are equipped with pipe (90 percent) and inserted (10 percent) sucker-rod pumps that have plungers 28-43 mm in diameter and are driven by SKN5, SKN6 and 7SKN pumping jacks. Industrial tests of screw-type, hydraulic-piston and jet pumps are being conducted.

The average indicators of the group of pumping wells in Western Siberia are presented in Table 1.

In the pumping well operating process, the matching of the elements of the bed-well-pump system is evaluated by the delivery coefficient. According to this indicator, up to 77 percent of the wells in the fields of Western Siberia are operating in the matched mode. As the result of inaccuracy in the engineering calculations for the operation of the system because of a lack of reliable information on the object of exploitation, as well as a shortage of high-productivity installations, about 23 percent of the wells are working in a pump operating mode that is more [sic] than optimal.

Basically, pump operation in a mode that is less than optimal is characteristic of ShGNU's [sucker-rod borehole pump units] and is the result of abrasive-corrosive wear of the plunger and valve pairs.

Operation of the bed-well-pump system in an unmatched mode reduces oil production and causes the installations' energy indicators and operational reliability to deteriorate. A reduction in the liquid output from the

Table [illegible]

[illegible]	(1)	(2)	(3)
[illegible] (4)	[illegible]	[illegible]	[illegible]
[illegible] (5)	[illegible]	[illegible]	[illegible]
[illegible] (6)	[illegible]	[illegible]	[illegible]
[illegible] (7)	[illegible]	[illegible]	[illegible]
[illegible] (8)	[illegible]	[illegible]	[illegible]

Key:

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Table 1

(1)	(2)	(3)		
		(4)	(5)	(6)
(7)	(8)	[illegible]	[illegible]	[illegible]
(9)	(10)	[illegible]	[illegible]	[illegible]
(11)	(12)	[illegible]	[illegible]	[illegible]
(13)	(14)	[illegible]	[illegible]	[illegible]

(15)

Key:

1. Deposit
2. Complicating factors
3. Number of failures, % of total number
4. Immersed electric motor
5. Cable
6. Pump
7. Megionskoye
8. Temperature
9. Samotlorskoye
10. Sand, salts
11. Sovetskoye
12. Curvature of well shaft
13. Trekhozernoye
14. Temperature, sand, salts
15. Note. The other failures took place in other equipment assemblies

In order to make a quantitative evaluation of the effect of natural factors and the operating conditions for pumping installations on their reliability, actual field data on the basic regions of Western Siberia underwent mathematical processing and a multifactorial correlation model of the formation of installation failures was constructed. According to the models, in order to improve the operational reliability of UETsN's it is necessary to develop measures to reduce the temperature and pressure at the pump intake, mechanical impurities, well shaft curvature, and the precipitation of salts in the units. As far as USHGN's are concerned, the measures must be directed at reducing abrasive-corrosive wear.

In order to lengthen the amount of time UETsN's operate between repairs under conditions of increased bed temperatures and pressures, it is necessary to develop units made up of immersible electric motors capable of operating when the surrounding medium's temperature is up to 90°C and cable that can function at temperatures of -50 to +90°C and pressures up to 200 kg/cm².

The effect of temperature and pressure on UETsN operation can be lessened by reducing the depth at which the pump is suspended in the well, while the effect of free gas can be lessened by installing dispersers and gas separators at the pump intake. Experience in using dispersing devices designed by SibNIINP and installed on UETsN's has been accumulated at industrial enterprises in Western Siberia. The prospects for their more extensive introduction in both Western Siberia and other areas of the Soviet Union depend on how quickly the production of pumps with built-in dispersing devices is developed and mastered at the UETsN producer plants.

tests of well gas separators, the operating principle of which is based on turning the flow of the gas and oil mixture through 180°, demonstrated their low efficiency. In connection with this, [illegible] developed and is conducting industrial tests of a [illegible]-type gas separator. So far, the results have been positive.

In deposits with heavy [illegible] in [illegible], most [illegible] [illegible] electric pumps of the [illegible] type have earned good recommendations. In order to prevent the precipitation of salts and paraffin in the pumping equipment, it is possible to recommend both Soviet and foreign-produced chemical [illegible] and modification of the equipment's surface for the purpose of imparting anti-adhesion properties to the precipitates. The first positive results have been obtained from the use of an acoustic field for this purpose.

The effect as well as [illegible] operations is [illegible] [illegible] [illegible] [illegible] standards for [illegible] [illegible] are observed during drilling.

Pipe string [illegible] [illegible] [illegible], which prevent cable deformation during tripping and lowering operations, also deserve attention.

Another direction for increasing the technical and economic indicators of pumping well operation is reducing downtime. An analysis of the downtime balance revealed that [illegible] percent of it is the result of organizational causes in each of the work crews. [illegible], the necessary pumping equipment type sizes are [illegible]. The number of repeated routine repairs of [illegible] pumping wells because of the low quality of the equipment and nonobservance of the specifications during installation operations is still significant. The elimination of these causes can increase the coefficient of exploitation by [illegible] percent.

Thus, the operating efficiency of the stock of pumping wells in Western Siberia can be improved only on the basis of an integrated approach to the solution of this problem. In connection with this, the following factors are necessary:

1. When creating pumping equipment, the specific conditions of its utilization in Western Siberia must be taken into consideration.

2. The quality of the pumping equipment and the [illegible] work done on it must be improved.

3. Development work for the creation of new pumping equipment, with particular emphasis on pumps with hydraulic drives, must be [illegible].

4. The complex of organizational problems relating to the maintenance, [illegible] and repair of pumping wells must be solved.

[illegible], V.A., and [illegible], A.A., "[illegible] [illegible] for the [illegible] [illegible] of Wells [illegible] with [illegible] Centrifugal Pumps," in [illegible] [illegible] of [illegible], [illegible], No [illegible], [illegible], pp [illegible].

[illegible]
[illegible]

UDC 622.276.72

ELIMINATING SALT DEPOSITS DURING WELL OPERATION

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 51-54

[Article by N.P. Dunayev, Glavtyumenneftegaz [Main Administration for Petroleum and Gas for the Tyumen' Region], N.S. Marinin and G.M. Yaryshev, SibNIINP [Siberian Scientific Research Institute of the Petroleum Industry], and T.A. Maryshev, Nizhnevartovskneftegaz: "Title as above"]

[Text] The problem of eliminating salt deposits in connection with the extraction of water, oil first appeared in the Western Siberian fields in 1971. By 1979 the number of wells where this factor complicated extraction operations had reached 562 (see the table below).

Deposits (1)	Change in the number of wells where salts are deposited, by years (2)							
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Shaimskoye group (3)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ust'-Balykskoye (4)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Samotlorskoye (5)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Zapadno-Surgutskoye (6)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Megionskoye (7)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sovetskoye (8)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Key:

1. Deposits
2. Change in the number of wells where salts are deposited, by years
3. Shaimskoye group
4. Ust'-Balykskoye
5. Samotlorskoye
6. Zapadno-Surgutskoye
7. Megionskoye
8. Sovetskoye

Salt deposition represents the greatest danger for the operation of pumping equipment. An example of this is the shortening of the operating period between repairs of the centrifugal electric pumps (ETsN) made by the "Reda" company to 50 -- and sometimes even to 7-20 -- days, as opposed to their guaranteed operating period of 2 years.

In 1976, 30.5 percent of all the ETsN failures at the Samotlorskoye deposit were attributable to salt deposits. In 1978 this figure increased to 41.8

percent. For the Shaimskoye group of deposits, the additional expenses for a well where salt deposition has taken place were 5,600 rubles, while for wells in the Samotlorskoye deposit the figure was about 27,000 rubles.

Taking into consideration the importance of solving the problem of eliminating salt deposits under conditions of intensive well flooding and a high rate of conversion of wells to mechanized oil extraction methods, in 1976 specialists from SibNIINP, Nizhnevartovsk and Glavtyumenneftegaz's NGDU (Petroleum and Gas Production Administration) began conducting research and experimental industrial projects for the purpose of studying the causes of salt deposition and developing methods to combat it. They studied the composition of the deposits (and established that they are primarily carbonate-calcium) and the basic hydrogeological, hydrochemical and thermodynamic conditions contributing to salt deposition [1-3], and also showed that the stratal waters in the deposits are of the calcium chloride and sodium hydrocarbonate types. As a rule, the salt deposition process is related to incompatibility of the injected and stratal waters and the removal of carbon dioxide from the waters during the extraction of the oil.

As a result of the research, methods were developed for the chemical and physical protection of the equipment with reagents -- inhibitors of salt deposition that are added to the output from the well -- and by the effect on it of an acoustical field.

Beginning in 1975, sodium hexametaphosphate (GMFN) was used as an inhibitor in the Samotlorskoye and the Shaimskoye group of deposits. This substance was constantly added to the well output and was used to treat injected water in the bed pressure maintenance (PPD) system. The addition of GMFN to the output of 10 production wells in the Samotlorskoye deposit made it possible to extend the period between repairs for several of them by a factor of 1.5-2, while for all the experimental wells as a whole, the period between repairs was lengthened by an average of 37 percent.

In three injection wells in the KNS-1 area of the Samotlorskoye deposit, the treatment of the injected waters with reagent in a concentration of 10 g/m³ from April 1977 to August 1978 did not produce a positive effect. Thus, it was established that under the conditions present in the Samotlorskoye deposit (stratal waters of the calcium chloride type), it is inadvisable to use GMFN because of its low inhibiting activity and hydrolysis.

In the Shaimskoye NGDU's Severo-Teterevskoye deposit (stratal waters of the sodium hydrocarbonate type), the waters injected for PPD were treated in 11 wells. The treated-water front was approaching the production wells by January 1979. No salt deposition has yet been noted in these wells. The effectiveness of the use of GMFN in this deposit will be determined upon completion of the experiment.

In the Samotlorskoye deposit, since June 1978 more than 100 wells have been involved in extensive experimental industrial testing of imported salt

deposition inhibitors produced by the "Petrolayt" and "Esso Chemical" companies. Two testing methods are being used: constant injection of the inhibitors into the space beyond the well pipe with the help of metering pumps, and injection of the reagent into the bed zone near the well bottom.

The constant injection of reagents into the space beyond the well pipe, in the amount of 20 g/t of extracted water, made it possible to lengthen the operating period between repairs from 92 to 204 days (on the average), while for ShGNU's (ESP's), the lengthening of the operating period was to 331 days (Petrolayt reagents) and 197 days (Esso Chemical reagents). Although premature failure of the ESP's were observed during the tests, they were basically not related to salt deposition.

The extensive use of the method of constant injection of reagents into the space beyond the well pipe involves serious complications because of their high corrosive activity. For instance, the ND-50-150 metering pumps were in operation for an average time of 14 days. During the 7 months of operation of 65 metering pumps, the plunger pairs were changed more than 200 times because of corrosion. There are grounds for assuming that the protracted injection of reagents into the space beyond the well pipe can lead to corrosion of the production strings and the NKT. Therefore, in order to introduce this method it is necessary to study the effect of injected reagents on the reliability of well equipment and to develop and begin series production of a standard series of metering pumps in a corrosion-resistant version.

Among the defects of this method, we should also include the lack of protection against the deposition of salts in the well and beneath the pump's intake in the bed zone near the well bottom, which reduces the well's yield. For instance, after 5 months the liquid yield from well 4529 decreased from 750 to 300 m³/day, in 2 years the yield from well 317 went from 1,000 to 350 m³/day, and over a period of 10 months the yield from well 4515 dropped from 1,000 to 100 m³/day.

In connection with this, a method of particular interest is that of protecting oil production equipment from salt deposition with the help of the addition of reagents to the bed zone near the well bottom. When this method is used, the deposits are flushed out of the well and a calculated amount of a 10-20 percent solution of the reagent is injected and forced into the bed zone near the well bottom by flushing liquid in an amount approximately equal to the daily volume of water extracted as a by-product. Tests of this method in more than 80 wells have shown that when the reagents are injected into a bed properly (in wells 2020 and 2021, for example), after the first treatment the wells function without salt deposition for 3-4 months, after the second -- up to 8 months, after the third -- more than a year (before the reagents were introduced, the wells' operating period between repairs was 20-50 days).

At the same time, when the method is used on a large scale the effect is considerably less. For instance, because of a shortage of specialized

equipment and the lack of the appropriate conditions. Of the [illegible] wells treated with [illegible] reagent, [illegible] treatments were performed only in [illegible] wells. [illegible] of the wells [illegible] failed after [illegible] days of operation as the result of decreased electrical insulation [illegible] wells and [illegible] of the pumps [illegible]. An inspection of [illegible] pumps that were [illegible] showed that [illegible] ... including the upper and lower [illegible], the [illegible], the shaft and the [illegible] system.

The washing of the [illegible] is [illegible] related to the [illegible] liberation of [illegible] from the [illegible] after reagent injection and the [illegible] of the highly concentrated reagent solution and the [illegible]. For instance, [illegible] percent of the [illegible] analyses during the [illegible] months before the reagent injections, the mechanical impurity content did not exceed [illegible] mg/l, whereas after the injections the impurity content increased to [illegible] mg/l in [illegible] percent of the samples, at [illegible] levels of [illegible] mg/l for [illegible] pumps and [illegible] mg/l for [illegible]. At the same time, the results of an analysis of the [illegible] in the [illegible] of [illegible] treated with [illegible] reagent showed that their content did not [illegible].

One of the important factors that determines the quality of the work on injecting reagents into a [illegible] and the effectiveness of the utilization of this method is the [illegible] for the [illegible] activities to be carried out at the [illegible]. Experience has shown that after the first treatment of the [illegible] wells, the amount of time before the reagent disappears varies within significant limits and averages about [illegible] days. In connection with this, the amount of time does not increase [illegible] if the first injection is performed with the volume of reagent calculated to last for [illegible] days. After the second well treatment, the reagent remains in individual wells for up to [illegible] days, and up to [illegible] days after [illegible] treatment. However, it frequently happens that the reagent [illegible] does not increase after the second treatment, but even decreases. All of this is indicative of unsatisfactory performance of the reagent injection work.

As foreign experience has shown, the [illegible] of reagents is effective [illegible] the volume of liquid [illegible] during injection equals the daily volume of water extracted. For [illegible] wells, which are typical of the [illegible] deposit, this volume is [illegible]. [illegible] this amount of water [illegible] requires the treatment of [illegible]. However, reducing the amount of [illegible] liquid shortens the amount of time it takes for the reagent to disappear from the [illegible]. In connection with this, [illegible] the necessity of furnishing [illegible] with equipment that makes it possible to perform high-quality injection work on an [illegible] basis, as well as the [illegible] technical standards, [illegible] techniques and instructions.

The shortcomings of this method also include the necessity of halting the pumping equipment before injecting the salt deposition inhibitors into the bed zone near the well bottom. If they are injected through the space behind the well pipe of wells equipped with ESNP's, the electrical cable's insulation is damaged quite frequently. In view of all this, it is necessary to investigate ways of increasing the time it takes for inhibitors to disappear from the bed.

Since 1979, Soviet-made salt deposition inhibitors based on oxyethylidene diphosphonic acid (OEDFK) and a polyelectrolyte (PAF-1), as suggested by specialists from SibNIINP, the Ural Forestry Engineering Institute and the All-Union Scientific Research Institute of Chemical Reagents and Ultrapure Chemical Substances, have been undergoing tests at the Samotlorskoye deposit. Positive results have already been obtained for some wells, while the tests are continuing in others. In order to utilize these reagents more successfully, it is advisable to accelerate the solution of problems related to the industrial production of Soviet salt deposition inhibitors in a form that is convenient for use, that is, it is necessary that the reagents be sufficiently active, that their freezing temperature not be above -45 to -50°C, and that they be delivered in the form in which they will be used in the wells.

There is considerable interest in the use of acoustical fields to prevent salt deposition in pumping equipment [7,8]. The method consists of sharply increasing the intensity of the process of salt crystallization in a liquid because of the effect on it of an acoustical field, after which the salt is removed from the well. The acoustical field is created by hydrodynamic emitters (acoustic flow converters) that replace one or several operating stages in an ESNP. These emitters were designed by SibNIINP, the All-Union Scientific Research Institute of Nuclear Geophysics and Geochemistry [5] and Nizhnevartovskneftegaz's TsNIL (Central Scientific Research Laboratory) [9].

[illegible] of ESNP's with acoustic flow converters have been carried out in [illegible] wells in the Trekhozernoye and Samotlorskoye deposits. Their period of operation between repairs increased to 150-200 days. However, the areas of application of this method as a function of the oil's properties and water content, mineralization of the water and the pressure and temperature of the medium have as yet not been sufficiently studied and substantiated, nor have the elements of the converter design that will insure protracted and reliable converter operation been finally decided upon.

Under the conditions present in the oil fields of Western Siberia, yet another method of eliminating salt deposition is usable. The results of scientific research projects conducted to study the compatibility of stratal waters of different types with injected waters show convincingly that in deposits with stratal waters of the calcium chloride type, it is advisable to use [illegible] waters (which prevent salt deposition) for flooding. The subsequent return of [illegible] water into the PPD system also should not cause salt deposition.

[illegible]

[illegible]

[illegible]

1. [illegible]

2. [illegible]

3. [illegible]

4. [illegible]

5. [illegible]

[illegible]

USSR

UDC 622.276.[illegible]

MEASURING THE YIELD AND FLOW RATE OF WELLS IN THE SAMOTLORSKOYE DEPOSIT

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 54-5[illegible]

[Article by [illegible] and [illegible], Tyumenneftegeofizika: "Title as above"]

[Text] Quantitative measurements of the yield of wells under bed conditions are of considerable practical importance for monitoring the entitlement of individual beds in the development process. In [1] the author pointed out the possibility of making quantitative measurements of the yield of producing and the flow rate of injection wells with submerged, series-produced yield- and flowmeters, providing that the instruments are calibrated under production conditions during the operating process. In this article we discuss the sources of errors and their magnitudes, in addition to ways of improving the accuracy of quantitative measurements.

In this case, the basic sources of errors are errors in the flowmeter unit and the measurements. According to [2], the total basic error in the flowmeter units used by the Nizhnevartovsk Industrial Geophysical Office (PGK) is [illegible] percent.

Measurement error is determined by instrument error during the measuring process and the error caused by the discrepancy between the thickness of the casing string's wall and the thickness of the flowmeter unit pipe's wall. According to the data amassed at the Nizhnevartovsk PGK, their maximum values are [illegible], [illegible] and [illegible] percent, respectively, for a total measurement error of [illegible] percent.

The error in the method of measuring yield and flow rate with the help of well instruments is composed of the instrument error and the error in the measurement itself, and is [illegible] percent. Thus, the theoretical maximum error is less than [illegible] percent.

The effect of liquid viscosity on the performance of an RGT-1 well yield meter was studied in a flowmeter unit. In order to obtain working liquids with different viscosities, water was thickened with different concentrations of carboxymethylcellulose (KMTs). RGT-1 instrument No [illegible], with a hollow packer, was calibrated for viscosities of [illegible], [illegible], [illegible], [illegible] and

[illegible] the approximate concentration of [illegible] was [illegible] and [illegible], respectively. The results of the calibration show that the greatest discrepancies are seen in connection with high flow rates. The maximum discrepancy for a flow rate of [illegible] m³/day is [illegible] percent. If we take into consideration the fact that, under the [illegible] conditions present in the [illegible]lorskoye deposit, the oil's viscosity varies within very narrow limits (from [illegible] to [illegible] cSt), for a quantitative measurement of the waterless oil yield there is no need to allow for viscosity.

(1)	(2)	(3)	(4)	(5)	(6)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			(7)		[illegible]

Key:
1. Well No.
2. Flow rate, m³/day
3. Surface measurement
4. Well measurement
5. Difference in flow rate, m³/day
6. Relative error, %
7. Average error

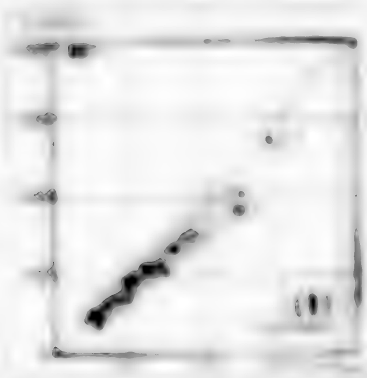

Figure [illegible]. Results of joint measurements of yield with a submerged [illegible] yieldmeter and a "[illegible]" device: 1, ideal relationship; 2, well [illegible]; 3, well [illegible]; 4, well [illegible].
Key: 1. [illegible]

In order that the results of the measurements of the injection wells' flow rates and the producing wells' yields might be compared, joint measurements were made with submerged instruments and surface devices. In injection wells [illegible] and [illegible], the water flow rate was measured with the help of [illegible] well flowmeter No. [illegible], which has a [illegible] (probably centerer), and an [illegible] surface ball flowmeter with a primary [illegible] instrument.

The [illegible] well flowmeter was calibrated before the measurements were made and after it had been used in the well. The instrument initially had an error of [illegible] percent, while on the second calibration it was [illegible] percent. The initial and repeated calibration graphs diverge by [illegible] percent, so that when the averaged graph is used, the error increases by [illegible] percent. The results of the measurements were used to construct a graph, the points in which fell satisfactorily onto the ideal relationship. The errors in the joint measurements are presented in the table. The average error is [illegible] percent. [illegible] table compares the errors of both the well and the surface instruments.

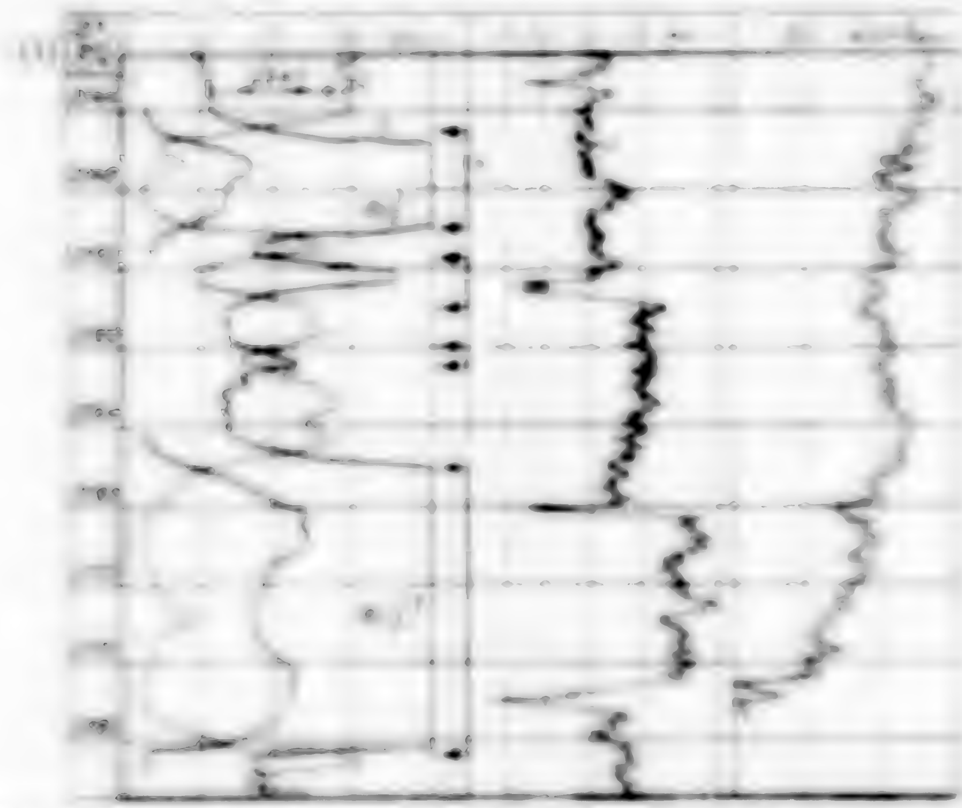

Figure 2. Example of the use of a casing string thickness graph during the quantitative interpretation of the mechanical yieldometers diagram for well [illegible] in the Samotlorskoye deposit: 1. PS (self potential) curve; 2. KS (resistance method in logging) curve; 3. perforation intervals; 4. SGDT thickness graph; 5. yield graph from RGT-1 with hollow packer.
Key: 1. Depth, m

Joint yield measurements were made with RGT-1 well yieldmeters and a measuring device of the "Sputnik" type in three producing wells (Figure 1). The yields measured with the Sputnik device have been corrected for the bed conditions, allowing for the oil's volumetric coefficient for each well individually. The RGT-1 yieldmeters were calibrated both before and after the measurements were made.

During the measurement of the yields from wells [illegible] and [illegible] the instruments' metrological characteristics did not change, but a slight discrepancy between the initial and repeated calibration graphs was noted for well [illegible]. The best coincidence of the yield measurement results was seen for well [illegible] (RGT-1 well flowmeter No [illegible], with a hollow packer, and Sputnik [illegible] measuring device No [illegible]). For this well, the average deviation of the measurements from the ideal relationship was [illegible] percent. The deviations from the ideal relationship were greater for the other wells. They cannot be explained by an error in the method of yield measurement with the help of well instruments.

Although the casing strings have a standard outside diameter, their wall thicknesses are not the same. For instance, the wall thickness of a [illegible]-mm casing string can range from [illegible] to [illegible] mm. This results in a change in the string's cross-sectional area and, as was pointed out above, can be a cause of error in determining the yield and the flow rate, since the flow rate is proportional to the cross-sectional area.

In Figure 2 we present an example of the use of a thickness graph (recorded with the help of an [illegible] instrument) in connection with the quantitative interpretation of the mechanical yieldometry diagram for well [illegible] (the well is waterless and the production string's diameter is [illegible] mm). The quantitative yield [illegible] was studied in accordance with the instrument's calibration graph, which was derived on a flowmeter unit with a measuring pipe having a wall thickness of [illegible] mm. In accordance with this, the total yield of the BV_6^0 and BV_6^{1+2} beds and the BV_6^{1+2} bed alone were [illegible] and [illegible] m^3/day, respectively. However, the conditions under which the measurements were made in the well differ from the calibration conditions, since the thickness of the casing string above the roof of the BV_6^0 bed was [illegible] mm (according to the thickness graph), while above the roof of the BV_6^{1+2} bed it was [illegible] mm. If we calculate the flow rates for the appropriate pipe cross-sections, the total yield is [illegible] m^3/day, while the BV_6^{1+2} bed's yield is [illegible] m^3/day.

The actual errors in the measurement of the yield and flow rate with well instruments were calculated for nine wells in the [illegible] deposit. According to these data, the average instrument error is [illegible] percent; the average error of the change in metrological characteristics during the measurement process is [illegible] percent; the average total error in the quantitative measurement of the yield and flow rate, allowing for the string's wall thickness, is [illegible] percent.

The experience gained by the [illegible] TGP in making quantitative measurements of the waterless oil yield and the flow rate of injection wells with the help of submerged instruments makes it possible to conclude that a further improvement in the accuracy of the measurements can be achieved by reducing the initial error and improving the stability of the measuring instruments' metrological characteristics.

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PROBLEMS RELATED TO THE COLLECTION AND TREATMENT OF OIL ENUMERATED

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 57-60

[Article by N.S. Maslov, Yu.N. Savvateyev and T.I. Fedorishchev, SibNIINP [Siberian Scientific Research Institute of the Petroleum Industry], and Yu.M. Kagan, Giprotyumenneftegaz: "Problems of Collecting and Treating Oil"]

[Text] Most of the oil in Western Siberia has the following characteristics: gas factor -- 40-100 m^3/t, density -- 0.85-0.87 g/cm^3, paraffin, tar and asphaltene content -- 2-4, 3-8 and 1-3 percent, respectively, bed temperature -- 70-90°C. These properties determine the low stability of the gas-and-oil foams and water-and-oil emulsions that form during the extraction and collection of the oil wells' output. However, there are deposits where the oil's gas factor is more than 1,000 m^3/t, its viscosity is more than 600 cp and its anomalous density is 0.95 g/cm^3 or more, which means that very stable water-and-oil emulsions that are difficult to break down are capable of forming.

In contrast to the waters of other deposits, the stratal waters that accompany the oil have a low degree of mineralization (15-30 g/l of salts) but contain calcium carbonate compounds that can settle out in the equipment and oil pipes along the entire path of the liquid's movement.

The intraindustry communication lines are laid under the most unfavorable conditions (swampy areas that are difficult to cross, little depth, a lack of thermal insulation and waterproofing). In some deposits these lines are of considerable length (100 km or more). All of this results in cooling of the extracted product to 0-5°C, particularly in separate, low-output deposits that are quite remote from the central collection points (TsSP).

As a rule, a TsSP receives from 50,000 to 200,000 t/day of liquid that requires treatment, that is, the degree of centralization is high. Here the advantages of centralization are especially visible: the number of objects requiring constant maintenance and transportation service is reduced, which is particularly important where there are no roads, and optimum conditions exist for the delivery of equipment, construction, the creation of residential complexes and so on.

in connection with the high overvaluation of the degree of centralization. However, the shortcomings of the existing production equipment are quite evident. Low equipment productivity, a shortage of monitoring and regulating devices and a low degree of plant finishing are the reasons that [illegible] are transformed into cumbersome, metal-intensive and expensive structures that are difficult to maintain. The rate at which they are put into operation lags behind the planned rate of growth of oil extraction, which delays the extraction and lowers the quality of the treatment of the oil.

Because of the delay in construction and the absence of block-type, plant-finished units for the demulsification of oil, a significant part of the well output is dehydrated and sent to the consumer in open tanks. Their presence in the production treatment systems leads to great losses of the valuable light fractions of the oil, creates or increases danger of fire and explosion and causes pollution of the environment. According to data gathered by [illegible], the oil losses during separation and from evaporation in the tanks at Glavtyumenneftegaz's (Main Administration for Petroleum and Gas for the Tyumen' Region) enterprises have reached 3 percent and can become even higher.

All of this shows how important it is for Western Siberia to develop new engineering solutions aimed at sealing oil collection and treatment systems, increasing the production equipment's productivity and reducing the amount of time it takes to manufacture and install it.

Below we have formulated several requirements for production equipment that is to be used under the conditions present in Western Siberia.

1. The separation unit must be made up of unitized production elements, each of which carries out only its own definite function: the elimination of pulsations, uniform distribution of the load among the equipment, removal of liquid droplets from the gas and so forth. It should be equipped with devices for the preliminary removal of gas that are located in the descending section of the intake pipe and that send the gas into a combination drop catcher and condensate trap [1].

2. The separator's design must be distinguished by its simplicity, the automatic units must have a minimum volume, and the presence of intensifying devices and drop baffles must be provided for. It is advisable to use direct-action or pneumatically driven regulators as the level regulators.

It is recommended that the maximum productivity of a Stage I separator be 30,000 t/day of liquid with a gas factor of up to 120 m^3/t (when the gas-lift method of well operation is used, it can be up to 250-300 m^3/t). Separate modifications of the separator should be designed for a gas factor of up to 1,000 m^3/t at a working pressure of 16 kg/cm^2.

The maximum productivity of a Stage II separator with preliminary disposal of the water should be 20,000 t/day of liquid. It must provide drainage water of a quality suitable for injection into the bed and dehydration of

the oil to the 1-percent level. The productivity of the separator for this separation must reach 2[illegible],000 t/day of liquid.

3. For integrated, high-productivity (20,000 t/day or more) collection points and for central industrial structures, the structural combination of the heating and sedimentation units in a single piece of equipment is not advisable, since it reduces the device's productivity. The structural combination of these units is justified for use in deposits with a liquid extraction level no greater than 10,000 t/day.

4. In block heaters and settling tanks there must be a minimum pressure gradient between the emulsion intake and outlet points. This will make it possible to eliminate transfer pumps, which create highly dispersed emulsions that are difficult to break down, from the oil treatment production system.

5. It is necessary to design the block heaters and settling tanks for a productivity level of 3,000 t/day of liquid. It is advisable to equip the heaters with regulators to maintain the oil at the given temperature, and the settling tanks with reliable direct-action or pneumatically driven regulators of the level of the water-oil interface.

6. The unified equipment must provide high mobility and the possibility of planning gas and oil collection and treatment systems that can be used under different conditions and at different stages of a deposit's development.

The development and use of such a complex of unified equipment will make it possible to insure complete sealing of the gas and oil collection, treatment and transportation system, reduce losses sharply, improve the quality and lower the cost of oil treatment, and reduce the interruption between the introduction into development and the physical setting up of a deposit for exploitation.

VNIISPTneft', TatNIINP, Giprotyumenneftegaz, Giprovostokneft' [State Institute for Planning and Research in the Petroleum Production Industry], TatNIPIneft' and GrNI [Groznyy Petroleum Institute] have done research that makes it possible to outline paths for the creation of such equipment and the solution of the other problems that have been pointed out. For example, highly efficient and high-quality gas and oil separation can be achieved by implementing the following measures.

1. The use of the intratubular demulsification effect. The results of TatNIINP and VNIISPTneft' studies of the effect of the characteristics of pipelines on the separation of gas and oil indicate that the productivity of gas-and-oil separators can be increased to 50,000 t/day for a gas factor of up to 200 m^3/t by using preliminary gas disposal devices (depulsators) [1,2].

2. The creation of a new technology for separating gas and oil directly in a pipeline or small units, using hydrodynamic effects and force fields.

Research performed by SibNIINP and Giprotyumenneftegaz substantiates the possibility and feasibility of treating thoroughly dehydrated and desalinized oil (up to 0.2 percent water and 40 mg/l of salts) directly at the western Siberian deposits. They have also developed a demulsification technique that makes it possible to keep the quality of the treated oil high while substantially simplifying the production system (by eliminating heat exchangers and reducing the number of demulsification stages), lower its heating temperature, reduce the intensity of salt deposition in the equipment and communication lines, increase settling tank productivity, and reduce the demulsifier consumption rate.

This new technique is based on double recirculation of the discharge water [3], the use of controllable devices for thorough breakdown of the emulsion [4], and gas-saturated demulsification using an electrical field. These technological methods have been accepted by Minnefteprom's [Ministry of the Petroleum Industry] departmental committees and are recommended for widespread introduction in the western Siberian fields.

On the basis of this technology, SibNIINP and Giprotyumenneftegaz have developed standard oil collection and treatment plans, the use of which is governed by the distances between the wells and TsSP's, well-mouth pressures and well yield rates [2].

The organization of the preliminary removal of water at booster [transfer] pumping stations (BNS) or at small deposits located at great distances from the TsSP's is important for western Siberia. In connection with this, the water's quality must be suitable for injection into a bed without additional purification.

Most promising in this area are the methods and equipment, suggested by Giprovostokneft', for the joint treatment of oil and water in which phase contact takes place as they move in opposite directions, in the form of drops, under the influence of gravity [6]. In order to reduce the metal intensiveness of the installations based on this principle, a device for the preliminary removal of gas that was designed by VNIISPTneft' and SibNIINP can be used as the separating element [5].

OGD-200 settling tanks designed by VNIISPTneft' and SibNIINP and equipped with the most modern distributing devices are effective at the stage of final dehydration of the oil.

No less important is the problem of reducing the consumption of expensive, imported demulsifying reagents, the basic consumer of which is western Siberia. Along with improving the technology of oil demulsification, their consumption can be reduced as the result of optimum use (the correct choice of the brand of reagent, depending on the properties of the water-and-oil

emulsion and the oil collection and treatment conditions, an improved reagent dispensing technology.

SibNIINP determined the activity level of demulsifiers for different oils and developed techniques for dispensing them in the form of oil solutions or emulsions, as well as recommendations on selecting the point at which the reagents are fed into the collection and treatment system. There are firm grounds for assuming that the optimum use of reagents will make it possible to reduce their consumption in the Western Siberian fields by at least one-third.

As a rule, these developments of the institutes have been approved under field conditions. The most important goal of both the production workers and the workers at the scientific research and planning organizations is the development and series introduction of new technical and engineering solutions for the conditions encountered in Western Siberia.

Along with this, it is still necessary to point out several areas in the creation of improved oil treatment equipment and technology that need further scientific research and experimental design work.

1. The development of a standard series of separators, with capacities of up to 5 million m^3/day, for the purification of casing-head gas.

2. Research and development of new techniques for the use of casing-head gas by chemical treatment, as well as its processing in the gas-hydrate state and others.

3. The investigation and synthesis of new and more efficient demulsifiers.

4. The development of oil treatment methods using electrostatic, magnetic, ultrahigh-frequency and combined fields.

5. The development of an electrodehydrator with a capacity of at least 500 t/hr of marketable oil, based on raw material with a water content of 40 percent.

6. The development of settling tanks with a capacity of 30,000 t/day that have coalescing filters for the purification of industrial waste water.

In our opinion, a fundamentally new approach to the creation of heaters for oil treatment installations is necessary. The existing heaters are not very efficient. Carbonate salts are deposited intensively in the heating pipes. Because of the high temperature gradient and the difference in pressures in the space inside and outside the pipes, there is a high probability of burnout, which puts the pipes out of commission.

It is advisable to discuss the possibility of using equipment of the contact type, based on new principles of mass and heat exchange, in which the liquid is heated directly by gas combustion products. According to

preliminary calculations, the metal-intensiveness of contact heaters is an order of magnitude less than that of pipe furnaces, while their efficiency approaches unity. In addition to this, salts are not precipitated in contact heaters as they are in standard ones.

In the near future, it is planned that oil deposits will begin being developed in areas where the natural and climatic conditions are quite complex, such as the Russkoye deposit in the northern part of Tyumenskaya Oblast. The characteristics of deposits similar to Russkoye (high oil viscosity in combination with a low gas factor, location in the permafrost zone, remoteness from oil refining points, comparatively small extractable volumes and so on) make it necessary to look for treatment methods that are fundamentally different from those now in use.

The basic objects of research, which are related to the collection, treatment and transportation of oil from the Russkoye deposit, are as follows. First of all, there is a study of the oil's component composition for the purpose of making recommendations for its rational use in the national economy. On the basis of preliminary data gathered by VNIINP [All-Union Scientific Research Institute of the Petroleum Industry] and BashNIINP [Bashkir Scientific Research Institute for Petroleum Processing], it has been established that oil from the Russkoye deposit contains a large amount of components that can serve as the basis for producing coke, which is a valuable initial product for the manufacturing of electrodes in the electrochemical and metallurgical industries. In connection with this, it is necessary to substantiate economically the most rational variant for the development of the deposit and the collection, treatment and transportation of the oil that will make it possible to preserve the valuable products mentioned above.

In these objects we should also include investigations of the rheological properties of the oils and water-and-oil emulsions and the development of recommendations for a rational method of lifting and transporting the extracted product. This research is pursued for the purpose of studying the rheological properties of oils and water-and-oil emulsions as functions of the extracted product's water content and the temperature conditions under which the oil pipelines operate in different sections of the gas and oil collection and trunk oil pipeline system, as well as the method used to extract and treat the oil in the Russkoye deposit.

Although the oil in the Russkoye deposit is distinguished by its low gas content (10-12 m^3/t), its high viscosity and low bed temperature, in addition to the greater heat losses in the ground that is the result of laying of oil pipelines in permafrost zones, create the prerequisites for significant deterioration of the conditions for removing gas from the oil in existing separators. Depending on the method used to develop a deposit, there can appear new requirements for oil separation equipment and technology and the necessity of developing fundamentally new and improved separator designs.

The high heat losses from oil pipelines under the conditions present in the Far North and the oil's high viscosity make special demands on the laying of pipelines and the measures instituted to insure their accident-free operation. It is necessary to take different variants of the pipeline-laying process into consideration: without supports (in or on the ground) but with thermal insulation, and with the use of special supports that insure the protection of the surrounding environment. It is necessary to investigate and select the most economical method for transporting the well output to the treatment points and the commercial-grade oil to the places where it will be refined. Some of the possible variants can be hydrotransport, transporting the oil together with diluents (light oil, gas condensate), thermodestructive processing, container transportation.

On the basis of preliminary laboratory research performed at VNIINP and Giprovostokneftegaz it has been established that the oil in the Russkoye deposit forms highly stable water-and-oil emulsions with the stratal water. Dehydrating it to 1.0 percent residual water by the thermochemical method requires large amounts of reagent (up to 120 g/t of dissolvan [translation unknown]), the proper temperature (80°C) and a long settling period (9 hrs). According to VNIINP data, the process's reagent consumption rate and temperature can be lowered (to 50 g/t and 60°C, respectively) if the water-and-oil emulsions are processed in commercial-frequency electrodehydrators. This research was carried out under laboratory conditions, using man-made emulsions.

In view of the fact that most of the complex problems concerning industrial management do not yield to modeling under laboratory conditions, there has arisen a need for conducting a whole complex of full-scale field investigations aimed at the selection, creation and development of the equipment and technology for collecting, treating and transporting the highly viscous oil from the Russkoye deposit. The research needs to be done with due consideration for the recommended methods of developing the deposit and insuring the possibility of obtaining specific products from the oil.

In order to publish the initial data and recommendations for the most rational variant for planning the physical setup of the Russkoye deposit's development as soon as possible, to be followed by the development of analogous deposits, it is necessary to create an experimental industrial testing ground right now, under the existing conditions of operation of the first producing wells. This testing ground must become a permanent and primary project of the industrial management system.

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INVESTIGATING THE VOLUMETRIC PHASE RATIOS OF OIL GASSES

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 60-63

[Article by V.A. Pisatelev, P.M. Olevnik and G.M. Teryshev, SibNIINP [Siberian Scientific Research Institute of the Petroleum Industry]: "title as above"]

[Text] In the planning of gas collection, transportation and processing systems, the most important initial data are the volumetric phase ratios of the gasses. They are characterized sufficiently completely by such parameters as the pressure and temperature at the beginning of condensation and the krikondentermicheskoye [translation unknown] and critical pressures and temperature, as well as the volumetric ratio of the liquid and gaseous phases. All of these parameters are determined by calculative and experimental research methods. Even with all their advantages, experimental methods cannot be the basic ones used under the conditions present in Western Siberia, because the extensive variety of the oil gasses and the gasses in gas caps and gas-condensate deposits presupposes their presence in large volumes.

In this article we present the results of investigations of the volumetric phase ratios of oil gasses that were carried out primarily by calculative methods. In connection with this, the experimental data are check data in relation to the calculative data. All of the calculations were made by the well known method of phase equilibrium constants [1]. The critical pressure and temperature and the convergence pressure were determined according to G.S. Stepanova's technique, while the pressure and temperature at the beginning of gas condensation were determined experimentally, using the piezoquartz suspension method [2].

Even given the same conditions for the separation of different oils, the density and content of C_3 [possibly C_2] and higher gasses from the separation of oils from the western Siberian fields range from 0.8 to 1.6 g/10^3 cm^3 and from 0.2 to 3-4 vol. %, respectively. Therefore, in order to simplify the calculations, the convergence pressure was derived as a function of the gasses' density. For gasses with densities of 0.8-1.0, 1.0-1.3 and 1.3-1.6 g/10^3 cm^3, the convergence pressures are 100-120, 120-140 and 140-160 kg/cm^2, respectively.

Figure 1. Phase diagrams of oil gases for the Samotlorskoye (I), Fedorovskoye (II) and Var'yeganskoye (III) deposits: 1,2,3 - gases from the first, second and third stages, respectively, of oil separation; 4 - experimental data for gases from the first stage of separation.

Of all the variety of variants for collecting, treating and transporting gas in Western Siberia it is possible to distinguish three basic ones: transporting the gas to the consumer over a distance of 3–50 km without compression; compression of the gas to 100–120 kg/cm² and further transportation of it to the consumer, primarily via a gas-lift system; compression of the gas to 300 kg/cm² for injection into oil beds.

In the first variant, the gas is at a pressure of 2–12 kg/cm² and in most cases its temperature does not drop below 0°C. In this variant, it is necessary to know the temperature and pressure at the beginning of gas condensation and the volume of liquid hydrocarbon phase that precipitates out during the transportation of the gas. In addition to these parameters, when gas is transported under high pressure it is especially important to know the cricondentermicheskoye pressure and temperature and those at the end of boiling.

In the first variant it is necessary to take the volumetric phase ratios into consideration primarily in order to select the optimum method for separating the hydrocarbon liquid from the gas. For instance, in the first 30-km section of the gas pipeline linking KSP-3 and the Nizhnevartovsk GPZ in the Samotlorskoye deposit, 30 condensate collectors with a total capacity of 500 m³ were installed. The lack of accurate data on the amount of liquid phase precipitating out of the gas led to an unsubstantiated exaggeration of the number of condensate collectors by a factor of almost 10 during the planning stage. When selecting the optimum variant for gas compression and transportation, it is also necessary to take the volumetric phase ratios into consideration.

Thus, the correctness of the decisions made during the planning of oil gas collection, treatment and transportation systems is determined to a large degree by the accuracy of the data on the volumetric phase ratios. Errors made during the derivation of these data by calculative methods depend on the error in the determination of the gases' component composition (particularly the content of C_6 and higher gases), the choice of the convergence pressure and the accuracy of the equilibrium constants. In order to evaluate the effect of the content of C_6 and higher gases and the convergence pressure on the accuracy of the calculations, the volumetric phase

(1)	(2)	(3)	(4)	(5)	(6)	(7)				
						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(8)	(9)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(10)	[illegible]	[illegible]	[illegible]	[illegible]	(15)	[illegible]	[illegible]	[illegible]	[illegible]
	(11)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(12)	(9)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(10)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(11)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(13)	(9)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(10)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(11)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(14)	(9)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	(10)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Key:

1. Deposit
2. Oil separation stage
3. Critical pressure, kg/cm^2
4. Critical temperature, °C
5. Gas density, g/10^3 cm^3
6. Separation temperature, °C
7. Amount of liquid phase (g/m^3) for gas separation pressure (kg/cm^2)
8. Samotlorskoye
9. First
10. Second
11. Third
12. Fedorovskoye
13. Var'yeganskoye
14. Mamontovskoye
15. None

ration were determined for several gases with the other parameters being constants. It was ascertained that the accuracy of the determination of the content of C_6 and higher gases affects the results of the calculations of the amount of liquid phase most substantially at pressures close to the pressure at the beginning of condensation.

At relatively high pressures, a change in the content of C_6 and higher gases even by a factor of two has no practical effect on the results obtained. A convergence pressure of 100-140 kg/cm^2 also has practically no effect on the results of the calculations. Because of inaccuracy in the choice of the equilibrium constants according to the nomograms, for gas pressures close to the convergence pressure the error increases to 30-4 percent.

Figure 2. Condensation isotherms of oil gasses from the Samotlorskoye [1], Fedorovskoye [1] and Var'yeganskoye [1] deposits (1,2,3,4: same definitions as in Figure 1; 5: experimental data for gasses from the second stage of separation)

Figure 1 gives the phase diagrams for gasses at different stages of oil separation for deposits in western Siberia. Their lower branches (up to the krikondentermicheskaya temperature) correspond to the line of dew points, while their upper branches correspond to the line of boiling points. In general form, they resemble the phase diagrams of light, multicomponent hydrocarbon systems [1].

As is obvious from Figure 1, under conditions corresponding to transportation under low pressure most gasses should be in a single-phase gaseous state. However, the results of actual operation of the gas pipeline from KSP-1 to the Nizhnevartovsk GPZ showed that when oil gas's temperature is lowered to 0°C in the gas pipeline, 6-8 g/m^3 of hydrocarbon liquid settles out of it. This discrepancy between the calculations and the practical results is apparently explained by an insufficiently accurate determination of the content of C_6 and higher components in the gas, as well as the precipitation of liquid in drop form from the separation stages.

The table on the preceding page shows the critical temperatures of the oil gasses from several deposits. As is obvious from the table and Figure 1, they range from -40 to +10°C for gasses from the first stage of oil separation when the pressure is 7-8 kg/cm^2 and from -10 to +60°C for second and third separation stage gasses at a pressure of 2-3 kg/cm^2. The krikondentermicheskaya temperature is limited to the interval from -5 to +100°C. At temperatures higher than the krikondentermicheskaya temperature, the hydrocarbon system will be in a gaseous state [1].

Therefore, data on the krikondentermicheskaya temperature sometimes give an unambiguous answer when selecting the system for separating hydrocarbon liquid from the gas. For instance, when gas is transported with a krikondentermicheskaya temperature that is below 0°C and a low pressure in the gas pipeline, it is possible that only moisture will settle out. Its quantity is determined from nomograms, on the condition that the gas is completely saturated with moisture. For nonequilibrium saturation of the gas with moisture, the amount of water that settles out can be determined according to the dependence of the moisture content of oil gasses on the water content of the oil with which they are associated [3].

The krikondentermicheskaya pressure characterizes the maximum pressure on the line of boiling points. At pressures greater than the krikondentermicheskaya pressure, the gas can be only in a single-phase gaseous state. For some gases this pressure does not differ substantially from the critical pressure, and on the whole it ranges from 80 to 200 kg/cm².

Thus, after compression to 300 (and sometimes 100) kg/cm², the gas will be only in a gaseous state.

The amount of liquid phase in real hydrocarbon systems under different conditions is shown in Figure 2 in the form of condensation isotherms and in the table. For several of the gases, a maximum is seen in the isotherms that is the result of the effect of retrograde condensation. At temperatures that are below critical, as the pressure increases all the gas is converted into a liquid at the pressure where boiling begins. The amount of condensate ranges from several grams to 1,000 g/m³ of gas.

Conclusions

1. When the composition of raw hydrocarbon gas is accurately known and the convergence pressure is chosen correctly, calculative methods give results that are in good agreement with experimental data.

2. The volumetric phase ratios given in this article can be used to solve practical problems relating to the collection, treatment and transportation of oil gases in the Western Siberian fields.

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PROCESSING OIL GAS

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 63-64

[Article by A.I. Vorivoshkin, Sibneftegazpererabotka: title as above]

[Text] A new industrial subbranch has been developed in Western Siberia: gas processing. With a shortening of the standard periods, capacities for the processing of 7 billion m³/year of oil gas have been created and put into operation. Every day, power workers, chemists and metallurgists in the cities of Surgut, Kemerovo and Novokuznetsk receive more than 23 million m³ of dry gas, about 3,000 t of a broad fraction of light hydrocarbons is sent to the European part of the Soviet Union.

The gas processing plants are under the control of Sibneftegazpererabotka [Siberian Association for Oil and Gas Processing], which was set up especially for this purpose and has on its staff experienced, highly qualified specialists. The construction and introduction into operation of these plants created the necessary prerequisites for the fulfillment of the program for the use of oil gas in Western Siberia. In connection with this, several new organizational and engineering decisions were realized and they had a significant effect on shortening the construction period and achieving high indicators for the work on the production installations. At the same time, serious errors were made and shortcomings were detected.

The transfer of the gas processing plants into Minnefteprom's [Ministry of the Petroleum Industry] system improved the situation for the use of oil gas, although several problems have not yet been completely solved. For instance, there is still no integrated planning and physical setup of oil fields from the viewpoint of complete utilization of oil gas resources from the beginning of the industrial development of the fields. As was previously the case, the problem of its collection and utilization is not solved in the oil field development plans. It is only sometimes that it is pointed out, in an explanatory note, that there will be a separate plan for the use of oil gas. Here it is necessary to mention that the planning institutes do not formulate such goals in their plans for the physical setups on the fields. In practice, some institutes have separate assignments to plan the development of deposits and a gas and oil collection system, while others plan gas processing plants using initial data that differ from the

actual facts. For example, all three operating stages of the Nizhnevartovsk GPZ [gas processing plant] receive gas whose composition differs from that specified in the plan. Because of a lack of coordination of the plans for the development of the deposits and the three stages of the Nizhnevartovsk GPZ, gasses from separation stages 2 and 3 are not sent to the plant. Therefore, in order to avoid putting out of operation compressors designed for the heavier gas, the operators have been forced to maintain a higher pressure at the plant's intake. The Yuzhno-Balyk GPZ's startup compression complex is still not charged with gas because of the lack of preparedness of the field collecting system.

The full use of oil gas can be insured only when gas processing plants are regarded as objects that are part of the unified field setup system and are planned and built simultaneously with the planning and setting up of the fields.

This can be achieved if the following measures are implemented:

1. In the work on the development of the technical and economic substantiation (TEO) for the physical setup at the fields, there should be a special section for TEO's for gas processing installations (plants) and the transportation of the finished product.

2. The engineering plans for gas processing installations (plants) should be developed on the basis of the data in the TEO's for the physical setup at deposits.

3. Gas processing plant projects should be included in the list of projects for the physical setup at deposits, which will eliminate parallel coordination of the construction title list at USSR Gosplan.

4. Gas processing plant projects should be closely coordinated with oil treatment projects as far as technology and cooperation between projects for auxiliary and power purposes are concerned.

In the development of a TEO for the physical setup at deposits, it is necessary to find a timely and integrated solution to all problems related to the marketing of the product (dry gas, the broad fraction, light hydrocarbons, ethane and so on) and getting connected to the unified system of existing gas, oil and product pipelines belonging to different ministries and departments. The experience gained in realizing the Nizhnevartovsk GPZ's output revealed serious omissions in the marketing of the finished product. For instance, as the result of a lack of preparedness on the part of the enterprises in the Kuzbass [Kuznetsk Coal Basin] region to receive dry gas, the Nizhnevartovsk GPZ's capacities have not been charged. At the same time, there is a well developed system of gas pipelines belonging to Mingazprom [Ministry of the Gas Industry] (such as the Urengoy-Chelyabinsk gas pipeline) that pass through a region where oil gas is not used.

The delay in the construction of the Tobol'sk chemical complex created a problem in the marketing of liquid hydrocarbons — an extremely valuable raw material -- since C_5 and higher liquid hydrocarbons obtained from gas can be injected into oil. This improves its demulsification to a considerable degree and does not cause the transportation conditions to deteriorate.

The technical and economic indicators of the operation of the Neftekumsk GPZ (Stavropol'skiy Kray) over a period of many years are indicative of positive experience in the joint treatment of gas and oil at industrial installations.

There are many problems that must be solved before oil gas can be completely processed. One of them is obsolete terminology, which has a significant effect on the attitude toward the use of oil gas. For example, calling it a by-product (as is done in some areas) gives a false idea of this valuable product. The expression "recovering gas" gives uninformed people the impression that oil gas is some waste product that can be ignored.

Oil gas that is extracted from oil taken from the depths of the earth and then burned in torches is an unrecoverable loss of fuel for the national economy and valuable raw material for the chemical industry. The successful fulfillment of the Party's requirements for the integrated utilization of the wealth in the ground in Western Siberia will make it possible to use oil gas in the service of our Motherland.

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EXTRACTION OF SPECIFIC COMPONENTS FROM OIL GAS DISCUSSED

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 64-65

[Article by Kh.S. Gabidov, T.K. Tokhtarova and A.G. Golovova, Minnibayevskiy GPZ: "Analysis of the Indicators of Processes for Extracting Specific Components From Oil Gas"]

[Text] In view of the fact that practically all of the available technological processes for extracting valuable components from oil gas (oil absorption (MAU), low-temperature rectification (NTR), low-temperature condensation and rectification (NTKR)) are used at the Minnibayevskiy GPZ [gas processing plant], a technical and economic analysis of the production indicators of these processes is a matter of particular interest.

The MAU unit operates at a temperature of 17-20°C and a pressure of 13-15 kg/cm². Hydrocarbon condensation in the NTR unit takes place at a temperature of -28 to -30°C and a pressure of 35-38 kg/cm². In the NTKR unit, the condensation temperature can reach -60°C at a pressure of 38 kg/cm².

Give relatively identical degrees of loading of these units, the operating expenses, degree of valuable component extraction and capital investments are far from being identical. The comparison of the units' technical and economic indicators that is presented in Table 1 shows that NTKR is the most efficient method. The profit from the realization of the output obtained from the NTKR unit exceeds that from the realization of output from the MAU and NTR units by factors of 7.8 and 1.6, respectively. The cost per ruble of commodity production is 27 kopecks for the NTKR unit, 20 kopecks for the NTR unit and 70 kopecks for the MAU unit. When the planned level of ethane production is reached with the NTKR units, the expenses per ruble of commodity production will be the lowest of the three.

The structure of the finished product's cost for the different technological extraction processes is given (in percentages) in Table 2.

The provisionally fixed expenditures related to the NTKR method are a small percentage of the finished product's cost structure, but reducing them is directly dependent on the stable operation of the units for extracting

Table 1.

[illegible] (1)	[illegible] (2)	[illegible] (3)	[illegible] (4)
[illegible] (5)	[illegible]	[illegible]	[illegible]
[illegible] (6)	[illegible]	[illegible]	[illegible]
[illegible] (7)	[illegible]	[illegible]	[illegible]
[illegible] (8)	[illegible]	[illegible]	[illegible]
[illegible] (9)	[illegible]	[illegible]	[illegible]
[illegible] (10)	[illegible]	[illegible]	[illegible]
[illegible] (11)	[illegible]	[illegible]	[illegible]
[illegible] (12)	[illegible]	[illegible]	[illegible]
[illegible] (13)	[illegible]	[illegible]	[illegible]
[illegible] (14)	[illegible]	[illegible]	[illegible]
[illegible] (15)	[illegible]	[illegible]	[illegible]
[illegible] (16)	[illegible]	[illegible]	[illegible]
[illegible] (17)	[illegible]	[illegible]	[illegible]

Key:

1. Indicators
2. GTA
3. GTBA
4. NGU (4 units)
5. Amount of gas processed, $m^3 \times 10^6$
6. Recovery from potential, g/cm^3
7. Production of liquid hydrocarbons, $t \times 10^3$
8. Cost of commodity production, rubles $\times 10^3$
9. Operating expenses, rubles $\times 10^3$
10. Cost of basic production funds, rubles $\times 10^3$
11. Gross production, rubles $\times 10^3$
12. Fund return per ruble of basic production funds, rubles-kopecks
13. Profit from realization, rubles $\times 10^3$
14. Recovery of basic production funds, yrs
15. Expenses per ruble of commodity production, rubles
16. Productivity of labor, rubles
17. Number of industrial production personnel

specific components from oil gas and increasing their recovery from the potential. The percentage of workers' wages in the cost of products obtained by the GTBA method is less than half what it is for the NGU and GTA methods and is only 3.9 percent of the total expenses.

Table 2

(1)	(2)	(3)	(4)
(5)	[illegible]	[illegible]	[illegible]
(6)	[illegible]	[illegible]	[illegible]
(7)	[illegible]	[illegible]	[illegible]
(8)			
(9)	[illegible]	[illegible]	[illegible]
(10)	[illegible]	[illegible]	[illegible]
(11)	[illegible]	[illegible]	[illegible]
(12)	[illegible]	[illegible]	[illegible]
(13)	[illegible]	[illegible]	[illegible]
(14)	[illegible]	[illegible]	[illegible]
(15)	[illegible]	[illegible]	[illegible]
(16)	[illegible]	[illegible]	[illegible]
(17)	[illegible]	[illegible]	[illegible]

Key:

1. Expenditures, %
2. RDU
3. NTGR
4. GTR
5. Provisionally variable
6. Raw material and basic materials
7. Auxiliary materials
8. Fuel
9. Electricity
10. Steam
11. Water
12. Provisionally fixed
13. Wages
14. Deductions for social insurance
15. Amortization deductions
16. Current repair
17. Shop expenses

In the provisionally variable expenses in the finished product's cost, in connection with NTGR the largest specific weight (after raw material) is borne by the cost of electricity for the sole-production unit. At the same time, the cost of steam for this method is considerably less than for RDU and GTR. Thus, a comparison of the technical and economic indicators of the different extraction methods presented in Tables 1 and 2 shows that the NTGR method provides a higher output of specific products at a lower cost.

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IMPROVING RELIABILITY AND SAFETY OF ELECTRICAL EQUIPMENT ADVISED

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 68-71

[Article by N.P. Abdomynin, VPO Soyuzneftegazpererabotka [All-Union Production Association for Oil and Gas Processing], and N.Z. Pomanov, Giprotruboprovod [State Institute for the Planning of Main Pipelines]: "Improving the Reliability and Safety of the Electrical Supply and Electrical Equipment for Oil Industry Projects"]

[Text] In most cases, oil industry enterprises obtain their electricity from electrical power systems operated by the USSR Ministry of Power and Electrification. Improving the reliability of their supply of electricity is a problem of great importance to the State.

In Minnefteprom [Ministry of the Petroleum Industry] a great deal of work has been done to improve the reliability of the power supply for oil industry projects (the introduction of new power capacities in oil drilling and extraction, oil pipeline transportation and at gas processing plants, the elimination of small-capacity and uneconomical electric power stations in Siberia and a changeover to supply them with power from power systems). In connection with this there have been improvements in the level of stability of the operation, quality and reliability of the power equipment. New engineering solutions have been introduced into project plans and other measures have been implemented.

The creation of a reliable power supply system for consumers expanded the use of electricity in production processes and contributed to the introduction of automated production control systems and the enlargement of the capacities of technological units in drilling and oil pipeline transportation and in Soyuzneftegazpererabotka's (SNGP) plants, which in turn determined new and increased requirements for power supply reliability.

Evaluating the present state of electrical installations in the zones of oil industry facilities, NPS's and gas processing plants where there is a danger of explosions required the determination of their conformity to the specific conditions for safe and reliable operation and the rules and norms during the planning and installation of the electrical equipment and power supply networks of installations where there is a danger of explosion, as

well as the development on this basis of suggestions and recommendations for improving planning decisions and the creation of new electrical equipment for use under the conditions encountered in Siberia and Turkmenistan.

However, the solutions necessary to insure safe and reliable operation are still not always provided for in the plans for the external and internal power supply of enterprises. The automatic restarting of electric motors after power supply interruptions caused by short circuits and the action of automatic reserve switching (AVR) and automatic recloser (APV) devices is sometimes not insured. The short circuit disconnection time is so long that it causes synchronous electric motors to fall out of synchronism and undamaged elements of the power system to disengage. Decentralized operation of frequency-controlled unloading (AChR) for disconnecting only the least critical consumers at enterprises is not being implemented. An extended asynchronous regime in the supply part of a power system is sometimes allowed. There have been cases of a nonsynchronous APV with thorough fitting of the voltage on the buses of substations from which consumers are supplied with a synchronous load.

The complete cessation of the power supply entails particularly severe consequences for several categories of consumers. The planning organizations sometimes incorrectly characterize a branch's consumers with respect to the degree of reliability and category of the power supply for different objects. They inadequately work out the engineering planning solutions for the integrated scientific and technical substantiation of a rational power supply for enterprises. Questions relating to the organization of a service for operating electric power plants are not taken into consideration when these plans are implemented, and this lowers the level of their future maintenance. Besides this, the existing power supply systems of some oil industry enterprises are characterized by a variety of planning solutions.

For example, for the power supply for oil-pumping stations (NPS) on main oil pipelines, in the 20u-10 kv plans Giprotruboprovod makes extensive use of 10-kv flexible overhead conductors with split phases (Figure 1) that are made of aluminum wire without a steel core and are up to 3 km long. The advisability of using them instead of a power cable to supply electricity to NPS's has been determined by the appropriate technical and economic calculations. They are economical for carrying, in one direction and over a distance of at least 0.4 km, electrical power of at least 20 mv-A [sic] at a working voltage of 6 kv and 25-30 mv-A [sic] at a voltage of 10 kv.

Other planning institutes such as YuzhGiprogazneftepreovod, PechorNIPIneft' and TatNIPIneft'[1] make little use of these conductors to supply electricity to the energy-intensive consumers at oil industry enterprises, NPS's and gas and oil processing plants.

As a result of an investigation of oil transportation projects conducted by Giprotruboprovod and VNIIproyektelektromontazh, recommendations were made for the safe and reliable supply of electricity and installation and operation of electrical equipment and power networks in areas (zones) where

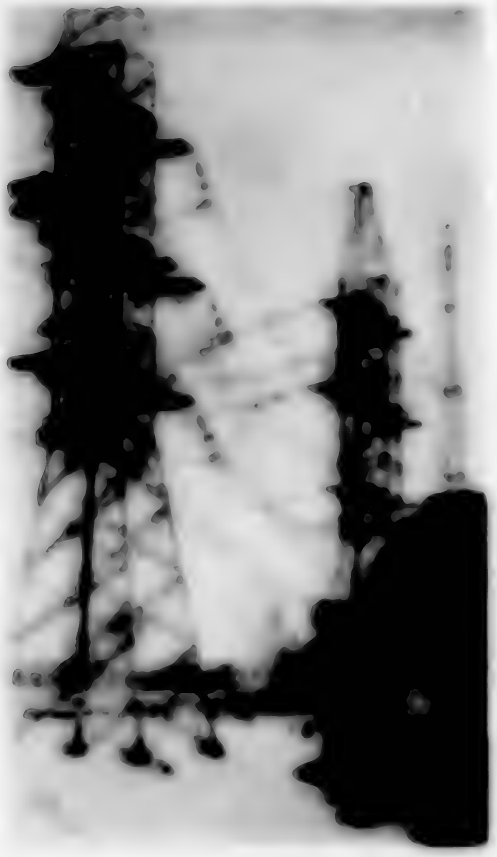

Figure 1. Flexible overhead conductors

there is a danger of explosions and that belong to Classes V-I, V-Ib and V-Ia and in Class V-Ig outside installation with dangerously explosive environments [illegible] according to the PUE [Rules for Setting Up Electrical Installations] that were included in the "Directives for Planning Power Installations for Main Oil Pipeline Projects," which were approved by Minnefteprom and put into effect in 1977. The primary attention was focused on the effect on electrical equipment and installations of factors in the surrounding dangerously explosive environment and the climatic factors characteristic of different regions (humidity, atmospheric precipitation, glaze ice, lowest and highest temperatures and their gradients).

In view of the fact that the electrical engineering industry is not fully satisfying the oil industry's need for electrical engineering equipment, both for the number and assortment of articles produced and their reliability, guides for the production of new electrical equipment have been prepared and published. They allow for the specific features of the construction and operation of electrical installations by the oil industry. For example, the introduction of the new UR series bus-and-switch structures, which were developed by the Donetsk Scientific Production Association of Explosionproof Equipment at Giprotruboprovod's request, is continuing. Their use increases the safety and reliability of the power supply for the electric gate valves in pipelines, which are used in large numbers, and reduces significantly the consumption of scarce cable products and the total number of communication lines at enterprises.

Explosionproof synchronous motors in a scavenging version, installed along with technological units in a single dangerously explosive Class V-Ia area, are widely used at VPO Sevuzneftepodgotovkaotbolsa's plants.

The experience gained in operating them for extended periods of time confirmed their reliability and economical qualities, even when they are used in the open air under only a roof. In connection with this, there is a great deal of interest in the new STDP series synchronous motors in a

sealed version, which are scavenged under excess pressure with a closed ventilation cycle. These motors have begun to be used in dangerously explosive Class V-1a areas at NPS's, particularly in connection with the widespread introduction of complete-unit pumping stations ([illegible], [illegible], [illegible]).

Development work is being done on synchronous motors for outside installation that will be used during the construction and assembly of [illegible]'s as complete units with pumping equipment located in the open air. The inadequacies of the series-produced STDP electric motors are taken into consideration in the published specifications for new electric motors. In these motors, current transformers for differential shielding will be installed under the housing, the lead-in of power cables from the side is specified. As far as their technical characteristics are concerned, the new motors will surpass the best foreign models.

In order to improve the reliability of the power supply, insure safety during the operation of electrical installations (including their use in dangerously explosive zones), reduce equipment idle time during preventive maintenance, and reduce the emergency reserve of electrical equipment in both standard and explosionproof versions, it is necessary to institute the following measures.

1. For each enterprise, develop and approve integrated plans of organizational and technical measures to improve the reliability and safety of electrical installation operation. At new projects, specify the widespread introduction of overhead conductors, fast-acting shielding, antiaccident automatic units, automatic starting for the electric motors driving critical production units, the automatic introduction of the reserve for critical consumers, integrated lighting installations ([illegible]) with slotted light guides, and the use of the newest methods for reinforcing the insulation of electrical installations operating in both normal and dangerously explosive zones.

2. Improve the systems for operating electrical installations and centralizing the repair services, as well as the technology and quality of repair work.

3. Carry out constant, careful investigations and analyses of instances of damage to electrical installations and operational failures of electrical equipment and networks for the purpose of developing measures to improve the operational safety and reliability of electrical equipment and installations.

4. Formulate branch techniques for accounting for losses suffered by branch consumers during interruptions in the supply of electricity from the side of the power system.

5. Increase the degree of plant installation readiness and the operational reliability of the new electrical equipment in units and articles for new

NPS's that are under construction (BKNS's, BMPNS's, BMGNS's, KTP's and others), including explosionproof equipment, which will make it possible to speed up considerably the installation of electric power plants in Siberia, Central Asia and the Far North by reducing the labor-intensiveness of the work at the installation site.

6. Give technical and methodological assistance during the planning and operation of oil industry projects by conducting investigations to determine the satisfaction of the requirements of the rules and standards by existing electrical equipment and networks, with subsequent preparation of planning and engineering solutions (including standard ones) with due consideration for the branch's special features.

7. Develop technical solutions for regulating (lowering) power consumption during peak load hours, followed by dissemination of positive experience throughout Minnefteprom.

8. Determine the coefficients and necessary parameters for calculating electrical loads during the planning of new and the renovation of existing substations and networks, which will make it possible to formulate normative documentation for the planning and renovation of the electrical network and substation management at different projects, reduce the consumption of nonferrous metal and transformer capacities, maintain the necessary level of reliability of electrical networks by predicting changes in electrical loads.

9. Enlist the workers operating the electrical networks in a discussion of the basic technical decisions in power supply systems that are in the planning stage and the selection of the type of drive for the basic engineering units.

10. Accelerate the development and approval of "Directives for Planning Electrical Power Supply Projects and Installations for Oil Industry Enterprises and Gas and Oil Processing Plants."

11. In the development of measures to improve the reliability of the power supply for enterprises, make use of the most economical technical solutions: the use of automatic accident-prevention devices, automatic frequency-controlled unloading, and a power supply system for devices for accidentfree halting of the technological production process that works in combination with technological shielding devices, control and measuring instruments and telemechanical equipment.

12. Develop "Rules for the Technical Operation and Planned Preventive Maintenance of Electrical Equipment and Installations in Oil Industry Enterprises," allowing for the special features of the operation and repair of electrical installations in this branch.

13. Develop "Guiding Directives for Protection Against Lightning and Static Electricity Phenomena of Oil Industry Production Installations and

structures; to replace the "Temporary Building Directives ..." that have been in effect since 1956.

14. Continue working on projects for the introduction of automated production process control systems (ASUTP) and automated planning control systems (ASUP) in combination with the electric drives of the basic machinery units used in the extraction and transportation of oil and in gas and oil processing plants, along with the development of the necessary algorithms and software for the basic production processes.

15. Coordinate, on an integrated basis, work on the planning and construction of external power supply projects for NPS's and compressor stations in sections where gas and oil pipelines parallel each other.

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DISCOVERING PRODUCTIVE BEDS WITH THE HELP OF SPECIAL EMULSION SOLUTIONS

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 10, Oct 79 pp 71-73

[Article by A.V. Kuz'min, Yu.F. Loginov, A.A. Sidorov and V.I. Tomashevich, SibNIINP [Siberian Scientific Research Institute of the Petroleum Industry]: "Discovering Productive Beds With the Help of Weighted, Thermally Stable, Invert Emulsion Solutions"]

[Text] At the present time, the productive beds in the Tyumenskaya Oblast deposits are discovered with turbodrills and flushing of the face with a clay solution treated with KMTs-600, GMFN [sodium hexametaphosphate], sigar [translation unknown], or oil. In regions with an increased formational pressure, the clay solution is made heavier with barite or hematite.

The productive beds are drilled out completely and spanned with a continuous 146- or 168-mm exploitation column, with subsequent separation with cement stone. Secondary discovery is carried out by cumulative perforation with a density of 20 otv/m [possibly openings per meter].

In the Salymskoye deposit, where a bed with anomalously high formational pressure has been discovered, an intermediate column is being lowered into the roof of the Bazhenovskaya formation and cemented. The productive bed was discovered with a 145-mm bit and subsequent lowering of a filter.

In connection with the existing technology for discovering productive beds using aqueous solutions, in some cases it is impossible to achieve the necessary quality, which is confirmed by data from measurements made with highly accurate yieldmeters in wells standing idle with a clay solution after perforation with the expectation of exploitation. Aqueous solutions have an especially strong negative effect on the productivity of low-productivity reservoirs, which include the following beds: A_1 in the Samotlorskoye deposit, AV_1 in the Sovetsko-Sosninskoye deposit, B_{8-9} in the Pravdinskoye deposit, B_{10-11} in the Zapadno-Surgutskoye and Yuzhno-Surgutskoye deposits, and the Tyumenskaya formation in the Mal'yanovskoye deposit.

The Salymskoye deposit's Bazhenovskaya formation belongs to a special category of reservoirs. The Yu_0 bed (the basic productive horizon) consists of

an alternation of massive and lamellar-foliar bituminous argillites. The formation is 30-44 m thick. The reservoir's geological structure has not been adequately studied. The information that has been obtained on the reservoir properties is inconsistent (the open porosity value ranges from 0.05 to 3 percent, the fracture permeability from 0.004 to 1.51 mD). The great variability in the porosity and permeability values obtained by different methods indicates that these methods are imperfect and that it is necessary to evaluate the indicators on the basis of field data.

At the present time more than 50 wells have been drilled into the Bazhenovskaya sediments. Their yields range from 0.05 to 370 m^3/day, the formational pressure is 400-405 kg/cm^2 and the temperature is 145°C, while the depth of occurrence is 2,700-2,800 m. The coefficient of productivity is low, and in the flowing wells ranges from 0.176 to 4.11 m^3/day (kg/cm^2).

In order to obtain reliable information on well productivity and the basic reservoir properties, it was decided to study the Bazhenovskaya sediments with the help of a thermally stable invert emulsion solution (IER) suggested by SibNIINP. Well 4-70 is located beyond the deposit's boundary. The Bazhenovskaya sediments were tapped with the IER and a core sample was taken with a 145-mm bit, using the rotary drilling method. During the third slotting, a well show indicated by a rise in the IER's level in the circulation system was noticed. After the tool was lifted to the column shoe and the hole's mouth was sealed through the preventer's working tap, the well was tested and a steady influx of oil with a flow rate of 40.1 m^3/day was obtained in a 6-mm pipe connection. The well was completed by drilling to the planned level with a clay solution weighted with hematite (the density was 1.56-1.60 g/cm^3 and the relative viscosity was 28-35 s). After this was done, the oil flowed in at a rate of 9.5 m^3/day in a 4-mm pipe connection.

The project to test the thermally stable IER for tapping the Bazhenovskaya formation continued in five wells in a single cluster in the Salymskoye deposit. In the preparation of the IER, an 8-10 percent oil solution of synthetic fatty acids (SZhK C_{20}) was used as the dispersion medium. The dispersed phase was a 30-percent solution of calcium chloride. The IER was prepared directly at the borehole. The ratio of aqueous and organic phases was 35:65. After the emulsion was treated with a solution of sodium hydroxide and an additive to make it hydrophobic was introduced, the IER was made heavier with barite with the introduction of an additional agent to make it hydrophobic.

During the drilling of the wells, the IER's density was 1.45-1.55 g/cm^3, its relative viscosity was 350-700 s and there was zero filtration. The solution's parameters did not change throughout the entire drilling process. After the filters were lowered, the wells were exploited by replacement of the IER by oil. For these wells, oil yields of 40-70 m^3/day were obtained.

In order to obtain an unambiguous answer to the question of the effectiveness of using IER's to discover productive beds, a shaft that revealed the productive reservoir with an aqueous solution was drilled parallel to a well. The experiment was conducted in the Pal'yanovskaya area of the Krasnoleninskiy arch. The productive part of the deposit lies in the Jurassic sediments of the Tyumenskaya formation (in the interval from 2,500 to 2,700 m), where there are several intercalations that are 3-10 m thick. The granular-type reservoir consists of dense sandstones, and its permeability changes sharply with respect to both area and thickness. The influxes of oil obtained during tapping of the bed with aqueous solutions range from 150 m^3/day during the flowing stage to several hundred liters at the dynamic level. The bed temperature is 145-150°C and the pressure is 280-300 kg/cm^2.

Earlier, well R-46 was successfully drilled in the Pal'yanovskaya area, with the Tyumenskaya formation being tapped with an IER. The dispersion medium was a 6-percent solution of SZhK in diesel fuel. The ratio of the aqueous and hydrocarbon medium was 40:60. The IER was made heavier with an iron ore concentrate, with the simultaneous addition of an agent to make it hydrophobic. Before the drilling began the IER's density was 1.20 g/cm^3, its relative viscosity was 450-500 St and there was zero filtration. During the drilling the solution's density increased to 1.24 g/cm^3 because of an accumulation of slime that was caused by the lack of a purification system. After the fourth slotting, the batch of solution coming from the well bottom was additionally stabilized by the introduction of SZhK and an agent to make it hydrophobic; this was done upon completion of the lowering and raising operations. The well was drilled without any accidents or complications. Geophysical instruments registered a well bottom temperature of 153°C. The well was developed by replacement of the IER with oil. A commercial-level influx of oil with gas was obtained, while the nearby wells, which were tapped with a clay solution, did not yield an influx of oil in this interval.

After a 245-mm jig was lowered to a depth of 400 m in well R-40, drilling was performed with 190-mm bits, using a clay solution, until the foundation was reached (2,693 m). The productive horizon in the 2,500-2,600 m interval was tapped with a clay solution with the following parameters: density — 1.20 g/cm^3, relative viscosity — 20 St, water yield — 6 cm^3/30 min, $SNS_{1/10}$ = 12/18 mg/cm^2. Core samples saturated with oil were raised from the interval indicated above.

A suspended 168-mm exploitation column was lowered into the roof of the Tyumenskaya formation, to a depth of 2,462 m. A slotted filter was installed and the well was tested with replacement of the IER by water. There was no influx. By lowering the level to the 800, 1,400 and 1,900 m marks, dynamic influxes of 0.41, 1.5 and 2.35 m^3/day were obtained, after which bass flushing lifted the stratal fluid (oil) in a total amount of 4 m^3. This completed the test, and a cement bridge was installed in the interval of the Tyumenskaya formation.

Well R-49 was drilled with the same rig, with the new shaft being cut from under the jig. A 190-mm bit was used to drill down to the Tyumenskaya formation's roof, using a clay solution, and a 146-mm exploitation column was lowered. Drilling from under the shoe of the exploitation column to the foundation of the Tyumenskaya formation (2,676 m) was carried out with a 118-mm bit and an IER. The dispersion medium was oil from the Pal'yanovskaya deposit that had 7 percent SZhK dissolved in it. The dispersed phase was a 30-percent calcium chloride solution. After treatment with sodium hydroxide, the IER was made heavier with an iron ore concentrate, with the simultaneous addition of an agent to make it hydrophobic, after which an addition 1 percent SZhK was introduced. The IER's parameters were: density -- 1.24 g/cm^3; relative viscosity -- 179 St; filtration -- zero; $SNS_{1/10}$ = 49/107 mg/cm^2.

The solution's parameters did not change during the drilling process (15 shuttlings) and no complications were observed. An 89-mm slotted filter was lowered into the open part of the shaft. The well was exploited by a transition from IER to oil. There was a stable, flowing influx of oil at the rate of 45 m^3/day in a 10-mm pipe connection, with a buffer pressure of 18 kg/cm^2 and a pressure beyond the pipe of 44.8 kg/cm^2.

Well R-49's horizontal displacement along the roof of the Tyumenskaya formation from well R-48 was 30 m. At this distance the productive beds are lithologically homogeneous.

Thus, the results obtained during the drilling and testing of the wells demonstrate the great effectiveness of the method of discovering faulted reservoirs under a depression with the help of an IER under conditions of high temperature and pressure.

11746
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UDC 622.276.52

OPERATION OF AIR LIFT EQUIPMENT UNDER SALT, CORROSIVE CONDITIONS

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 11, Nov 79 pp 32-34

[Article by B. T. Mollayev, A. P. Gasiyants, N. I. Akhmetzhanov and T. E. Kanashayeva, KazNIPIneft']

[Text] Wide industrial introduction of the air lift method of well operation at the Mangyshlak fields coincided with active flooding of productive beds and inoculation of them with hydrogen sulfide-reducing bacteria. This had a negative effect on the operational dependability of the air lift equipment used. The experience of operating it at the Mangyshlak fields showed that the weakest link which mainly determines the mean cycles between repair of air lift wells is the starting valve.

Analysis of a condition of 615 air lift valves of the KP-24 differential type, removed from wells during routine maintenance, made it possible to establish the nature of their malfunctions--the calibration was disrupted in 440 valves, the housing was destroyed in 41, the working cavity was clogged with paraffin in 22 and was stopped up with salt deposits in 140 valves (there were miscellaneous malfunctions in 60 valves).

It is obvious from the given data that one of the main causes of failure of valves is salt deposits. The question of the reasons for salt deposits in them is debatable since it was assumed that the salts are precipitated from the wet gas used for the air lift. The chemical composition of the water removed as a byproduct from the well, the water prevalent in the air lift gas (Table 1) and also the compositions of the solid deposits taken from the valves and connecting pipes of air lift well 77 of the Zhetybay field (Table 2) were analyzed to establish the nature of these deposits.

Analysis of the solid salt deposits from the valve (see Table 2) showed a significant content of $BaSO_4$ in them, the absence of $CaCO_3$ and insignificant content of NaCl. $CaCO_3$ predominates in the salt deposits from the connecting pipe.

Consequently, the $CaCO_3$ and $BaSO_4$ salts in the valve and connecting pipe could not come from the water present in the gas. However, the Ca^{2+},

Table 1

Object of investigation (1)	Ion content, mg/l (2)							
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Water contained in air lift gas (3)	[illegible]	(6)	[illegible]	(6)	[illegible]	[illegible]	[illegible]	[illegible]
Water extracted as byproduct from well 771 (4)	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cold Caspian Sea water (5)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	(6)	[illegible]

Key:

1. Object of investigation
2. Ion content, mg/l
3. Water contained in air lift gas
4. Water extracted as byproduct from well 771
5. Cold Caspian Sea water
6. None

HCO_3^-, Ba^{2+} and SO_4^{2-} ion content is significant in the water extracted as a byproduct at the Zhetybay field in which sea water predominates; therefore, low-soluble $BaSO_4$ and $CaCO_3$ compounds may precipitate out if the thermodynamic equilibrium is disturbed.

Thus, salt precipitation in air lift valves, subsequent deposition of paraffin in them and clogging with mechanical impurities were caused by contact of the valves with the well product. The contact occurs as a result of the flow of liquid through them during shutdowns and repeated starts of the wells and also during periodic flushings of the NKT (expansion unknown) to remove paraffin deposits. Moreover, direct flowthroughs (from the space around the pipe into the NKT) and reverse (from the NKT into the space around the pipe) are possible in wells equipped with KP-2 valves without a return delivery element.

Table 2

Object of investigation (1)	Content of substances, percent by mass (2)									
	(3)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	(4)
Salt deposits (5): from the valve (6)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
from the connecting pipe (7)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Key:

1. Object of investigation
2. Content of substances, percent by mass
3. Petroleum products
4. Residue insoluble in HCl
5. Salt deposits
6. From the valve
7. From the connecting pipe
8. None

direct flowthrough cannot present a serious danger with regard to salt deposits since it usually accumulates in the space around the pipe of an operated well. The main reason for salt deposits in KP-2? starting valves is obviously reverse flows of the flooded product of the well. This conclusion is also confirmed by the nature of the salt deposits around the inlet openings on the outside in the form of crusts which sometimes completely cover the inlets.

The equipment of wells with starting valves having no reverse delivery element also causes indirect erosion of the connecting pipe body in which the valve is installed by a jet of liquid from the valve openings during reverse flows. These disturbances, observed in wells of NGDU (oil and gas administration) Gazneft' and Zhetybayneft' occur as a result of flushing the NKT with hot water or condensate during deparaffinization and during restarts or during pressurization of wells.

In this regard valves must be lowered into the wells completely assembled with a reliable reverse delivery element. The space around the pipe of air lift wells must be sealed with packer to totally eliminate contact of the starting valves with the well product. The use of packers also permits a reduction of pulsation in wells and significantly reduces their restart and time.

Moreover, anticorrosion protection of the underground air lift equipment and anticorrosion treatment of the starting valves are required to prevent corrosion-related malfunctions of the valve. If a reagent is introduced, centralized delivery of it can be provided at gas preparation and distribution objects in the wells.

A complex of measures must also be implemented for extensive drying of the airlift gas and introduction of salt and corrosion inhibitors to it.

Expansion chambers in the gas lines of the air lift system and installation of separation apparatus and filters in the gas lines in front of the inlet to the gas distribution banks should be provided at the Kazakh GPZ (Gas Refining Plant). This permits not only a reduction of the moisture and liquid hydrocarbons content in the air lift gas, but also makes it possible to trap mechanical impurities, which significantly improves the operation of the monitoring and measuring devices, surface regulating devices and air lift valves.

Moreover, a new GOST (State Standard) must be worked out for the composition of the gas used in air lift production and also regulations must be worked out for the quality of products of air lift equipment.

6521
CSO: 1822

FUELS

UDC 622.276.8

GAS-SATURATED OIL PREPARATION AT KSP-10 OF SAMOTLOR FIELD

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[Article by B. M. Baykov, Minnefteprom, N. S. Marinin, V. A. Shipin and N. V. Kirillov, SibNIINP, R. I. Mansurov and G. N. Pozdnyshev, VNIISPTneft', and A. M. Ilyayev, NGDU Belozerneft']

[Text] The high rates of oil production and the complex natural and climatic conditions of Western Siberia contributed to the fact that the most progressive technology and techniques of production, gathering and preparation of oil have become widely used at the oil fields of Glavtyumenneftegaz (Main Administration for Petroleum and Gas for the Tyumen' Region). The following technical and production decisions have been made for development of the oil fields in the planning graphs of Giprotyumenneftegaz (State Planning Institute for Oil and Gas in the Tyumen' Region).

1. The use of bed energy--the pressure developed by submersible pumps and separator pumping stations for transport of the well products through all lines, including the oil preparation installation.

2. Early introduction of a demulsifier in the collecting system for preliminary preparation of the oil emulsion for separation.

3. Separate collection, transport and preparation of anhydrous and flooded oils.

4. Maximum centralization of the objects of the oil collection and preparation system, including preliminary dehydration objects and multiple collection points (KSP).

5. Disposition of central collection points (TsPS) for a group of oil fields with regard to the rates at which they become operational and also construction and introduction of main oil pipeline objects into operation.

The oil at the fields of Western Siberia is separated in 2-4 stages. The first stage is usually accomplished at separator pumping stations (DNS) or at a KSP at pressure of 1.5-6.0 kgf/cm².

The results of investigating the technology and technique of [illegible] oil preparation at KSP-[illegible] of NGDU (Oil and Gas Administration) Nizhnevartovskneft', where production of a desalinized commercial product in one stage without the use of fresh flushing water is possible due to extensive dehydration of the gas-saturated oil, and the characteristics of the physicochemical properties of the emulsion, are considered in the article.

Moreover, the operation capacity of the installation to prepare degassified oil using crude pumps is provided by the process flow diagram, i.e., two main versions are accomplished which are the basis of the "Standardized Oil, Gas and Water Collection and Preparation Production Complexes of the Oil-Producing Regions" (VNTP-[illegible]-76), recommended by Minnefteprom (Ministry of the Petroleum Industry) for guidance and practical application throughout the sector. The object of investigation--KSP-[illegible]--was of greatest interest in this regard and also in part of the volumes of the prepared oil and collection of the block equipment used since there was no experience in operating these installations until quite recently.

The investigations were carried out in [illegible]-197[illegible] jointly by workers of SibNIINP (Siberian Scientific Research Institute of the Petroleum Industry), VNIISPTneft' (expansion unknown) and NGDU Nizhnevartovskneft' by program coordinated with Minnefteprom.

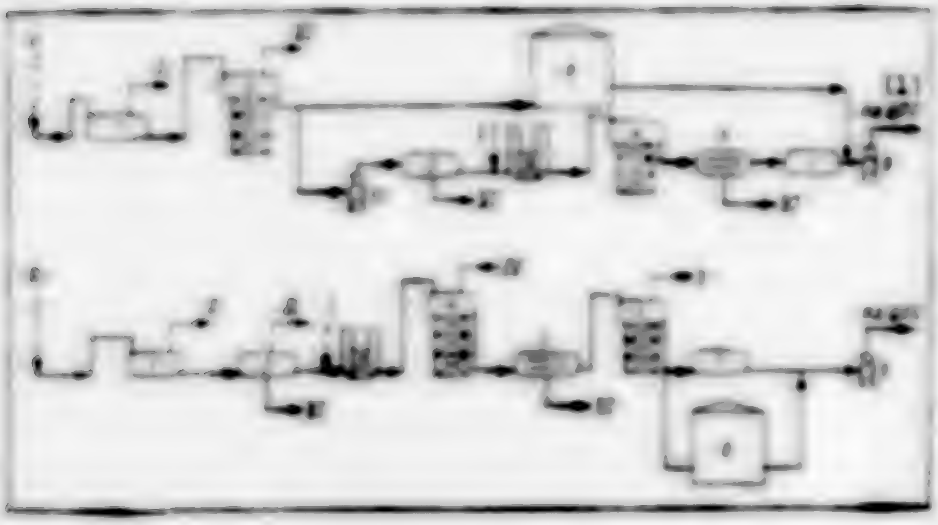
The process flow diagram of oil collection and preparation at KSP-[illegible] is presented in Figure 1 and the specifications of its individual components are presented in Table 1.

The characteristic feature of the installation is the use of highly productive heaters and electric dehydrators in it. The level of gas-oil separation in the separators of the [illegible] hot separation stage located on a support six meters high at a distance of [illegible] meters from the electric dehydrators was regulated by a [illegible] pneumatic level meter with membrane actuating mechanism (not shown in the figure) at the output of the oil from the electric dehydrator.

During preparation of the degassified oil (see figure, a), the liquid flow from the separators 1 enters the final separation unit [illegible]. Part of the oil is sent from there to tanks [illegible] and another part is delivered by pumps [illegible] (the unconditioned oil pumping station) to apparatus [illegible] of the [illegible]-200 type. It further moves according to the diagram.

The dehydrated and desalinized oil is pumped from the electric dehydrators [illegible] through booster tanks [illegible] to the user by pumps [illegible].

During preparation of the gas-saturated oil (see figure, b), the well product with water content of [illegible] percent is delivered to separators 1, from which the separated gas is sent to droplet traps (not shown in the diagram) and the liquid is sent to preliminary water collection tanks [illegible] of type [illegible]-200. The partially dehydrated oil ([illegible] percent water) is passed



Schematic Diagram of KSP-1? in Preparation of Degassified (a) and Gas-Saturated (b) Oil: lines: I--reagent and gas; II and V--first and second separation stages, respectively; III--from OG-200?; IV--hot separation; VI--water to purification plants. 1, 4 and 6--separator of first stage, before electric dehydrator and hot separation stage, respectively; 2--preliminary water collection tank; 3--tubular heater; 5--electric dehydrator; 7--buffer tank; 8--RVS-5000 tank; 9 and 10--pumps

Key:
1. to TsPS

sequentially through heater furnaces 3, the separator before the electric dehydrator 4, electric dehydrators 5 and the hot stage separators 6.

The water separated in tanks 2 and the electric dehydrators 5 is sent to the RVS-5000 reservoirs (not shown in the diagram) for purification by settling; the gas separated in tanks 2 and separators 4 is sent to a common line.

The dehydrated and desalinized oil from electric dehydrators 5 is sent to separators 6 of type NGS-6-100 installed at a height of 12 meters and is sent from them to tanks 8. It is pumped from the tanks by pump 9 to the user. The free gas separated during this stage is delivered to a separate line.

Non-ionogenic reagent-demulsifiers were delivered in concentrated form to the three pipelines (of 6) transporting the oil from well clusters before the first separation stage.

During the tests the temperature of the incoming raw material was maintained in the range of 17-20°C during the winter-spring season and 16-19°C

Table 1

(1)	(2)	(3)	(4)	(5)
1	[illegible] (6)	[illegible]	[illegible] (7)	[illegible] (8)
2	[illegible] (9)	[illegible]	[illegible]	[illegible] (10)
3	[illegible] (11)	[illegible]	[illegible] (12)	
4	[illegible] (13)	[illegible]	[illegible]	[illegible] (10)
5	[illegible] (14)	[illegible]	[illegible]	
6	[illegible] (15)	[illegible]	[illegible]	[illegible] (8)
7	[illegible] (16)	[illegible]	[illegible]	[illegible]
8	[illegible] (17)	[illegible]	[illegible]	[illegible]
9	[illegible] (18)	[illegible]	[illegible] (19) [illegible] (20)	[illegible]
10	[illegible]	[illegible]	[illegible]	[illegible]

Key:

1. Number in figure
2. Components
3. Number
4. Characteristics
5. Comments
6. First-stage separator
7. kgf/cm²
8. Developed by TsKBN (Central Design Office of the Petroleum Industry)
9. OG-200S settling tank
10. Developed by Design Office of Saratovneftegaz (Saratov Petroleum and Gas Association)
11. Heater
12. Mole-kcal/hr
13. Separator before electric dehydrator
14. Electric dehydrator
15. Separator of hot separation stage
16. Buffer tank
17. RVS tank
18. Pump
19. m³/hr
20. Meters of liquid column

during the summer-fall season. The ambient air temperature varied from -30 to +30°C; the pressure in the first separation stage varied from 4.[illegible] to [illegible] kgf/cm² and that in the hot separation stage varied from [illegible] to 4.[illegible] kgf/cm². The results of testing the electric dehydrators are presented in Table 2.

The water content in the oil at different points of the process flow diagram, the amount of occluded and residual gas in the liquid, removal of oil drops by the gas flow, the degree of breakdown and dispersion of the emulsion and the salt content at the outlet from the electric dehydrators were determined during the tests.

Table 2

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(8)						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	(9) [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] (10)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	(11) [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(12)						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Key:

1. Productivity, m^3/hr
2. Dehydration temperature, °C
3. Reagent flow rate, g/t
4. Water content of oil at inlet to [illegible], percent
5. Residual water content, percent
6. Stage of field
7. Reagent
8. Preparation of degasified oil (figure, a)
9. Cut off
10. [illegible]
11. Switched on
12. Preparation of gas-saturated oil (figure, b)

The following was established as a result of analysis and generalization of the data. The process flow diagram for preparation of [illegible] gas-saturated oil is efficient over a sufficiently wide range of incoming raw material temperature and productivity variation if the hot stage separators operate trouble-free. The latter depends significantly on the free gas content in the flow of gas-liquid mixture at the inlet and the speed of the automatic devices which maintain the level of gas-oil separation in separators 4 of type [illegible]. It was found that the main problems in the circuit operation are related to the design deficiencies of separators 4 with capacity of 25 m^3.

The small volume of the separators and the uneven operation of the automatic equipment for regulation of the level of oil-gas separation at increased productivity led to eruptions of gas into the electric dehydrators, which caused shutdown of them. Moreover, if the electric dehydrator productivity was [illegible]–400 m³/hr, increased removal of the drop liquid by the gas and of free gas by the oil flow from separators [illegible] was observed.

If the [illegible]-100 separator (capacity of 100 m³ and located at a height of [illegible] meters at a distance of [illegible] meters from the electric dehydrator) was used as the hot stage, more stable operation of the circuit was achieved. Removal of the free gas by the oil decreased appreciably and deviations of the electric dehydrators were not observed.

In all the considered operating modes of the oil preparation installation, the electric dehydrators showed high efficiency and effectiveness under the operating conditions stipulated by the regulations and at productivity up to [illegible] m³/h. In the case of degassified and gas-saturated oil preparation at temperatures of [illegible]–40°C, demulsifier flow rate of [illegible] g/t and productivity per apparatus of 500–[illegible] m³/hr, they provided export quality oil (water up to 0.[illegible] percent and salts up to 40 mg/l).

The electric dehydrators also operated reliably upon delivery of crude oil with occluded gas content up to [illegible] l/m³ without shutdown and appreciable reduction of processing quality.

Thus, the investigations showed the possibility of producing extensively dehydrated and desalinized oil in a single thermoelectrochemical stage using electric dehydrators with low input of raw material by the schemes for preparation of gas-saturated and degassified oil under conditions similar to the KSP-1 of the [illegible] field.

At the same time the need to work out some problems on [illegible] and the design version of the hot stage separators and also to solve the problem of collection and utilization of the gases of the second and third (hot) separation stages was determined for practical introduction of the given schemes.

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FUELS

UDC 622.24.06

DRILLING MUDS FOR WESTERN SIBERIAN FIELDS

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 11, Nov 79 pp 32-34

[Article by A. V. Kuz'min, Yu. F. Loginov, A. A. Sidorov, L. Ya. [illegible], V. N. Grigor'yev and A. I. [illegible], SibNIINP]

[Text] One of the reserves for increasing the drilling efficiency in Western Siberia is to improve the formulas of drilling muds. Natural clay mud treated with KMTs [Carboxymethylcellulose], [illegible], nitrolignin, GMFN [Sodium hexametaphosphate], graphite and oil is now used in well drilling. The introduction of oil and graphite to the drilling mud permits drilling of inclined wells essentially without accidents. The accessibility of oil as a reagent, the simplicity of the technique of introducing it to the mud and the high efficiency determined its use at the rate of 50-70 m^3 per well [1]. However, introduction of large volumes of oil pollutes the environment and increases the fire hazard.

The geological profile of oil fields of Western Siberia is represented by a thick mass of clay deposits with alternating sands, sandstones and aleurolites. The high drillability of rock and active hydration of sodium clays of the profile lead to intensive consumption of the natural clay mud with high indices of thixotropic properties. This makes it difficult to purify and stabilize the density of the drilling mud and contributes to formation of a brittle porous filtration crust on the walls of the well and as a result inhibits sinking of it. The actual density of the natural drilling mud produced upon tapping of productive beds significantly exceeds that provided by unified mining administration regulations due to the impossibility of removing the colloidal fraction of slurry from it. The density of the mud is controlled by partial discharge of it from the circulating system with subsequent dilution by water and stabilization with chemical reagents.

The purification system must be improved and effective chemical stabilizer-reagents and regulators of drilling mud dispersion must be rationally selected to improve drilling muds. It is suggested that sodium ethylsiliconate (GKZh-10) be used as the clay rock dispersion inhibitor.

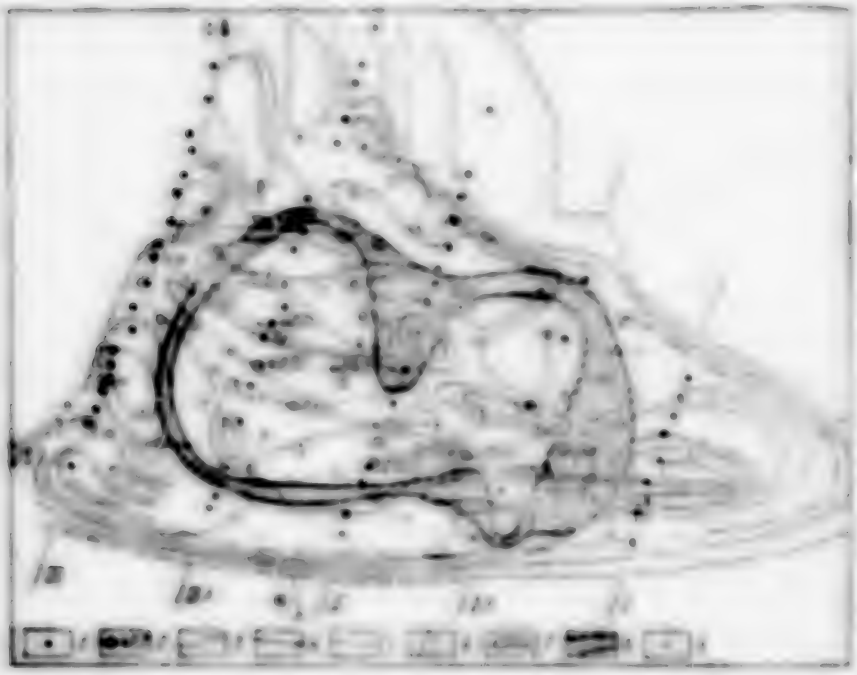

Figure 1. Chart of Variation of Effective Oil-Saturated Mass of Horizon XIV of the Southeastern Part of the Uzen' Field (From Data of the VNII, 1973) with Zones $p_{pl} < P_{nas}$: wells: 1--ejection of horizon XIV; 2--in which shows occur; 3--isopachs; 4 and 5--outer and inner contours of oil bearing content, respectively; 6--injection series; 7--first zone with $P_{nas} - p_{pl} \geq 1.0$ MPa; 8--second zone with $P_{nas} - p_{pl} = 0.5$–0.9 MPa; 9--wells drilled without shows

Shows whose occurrence cannot be explained by existing principles of distribution of p_{pl} in the area of productive horizons began to be encountered when drilling wells sometime after the beginning of intraded flooding. Most wells in which intensive gas, oil and water shows were observed are located on the southeastern limb of the Uzen' fields (Figure 1).

The shows occurred mainly at oil horizon XIV of the Upper Jurassic, lying at depths from 1,160 to 1,290 m. The moment of their occurrence usually coincided with the process of drilling the roof of this horizon and gas bubbles appeared in the drilling mud with subsequent transition of it to "boiling." The well began to gush.

The influx of gas into the drilled well is explained by the fact that a local gas cap formed as a result of separation of the gas from the oil with a decrease of p_{pl} below the saturation pressure P_{nas} is tapped in the oil bed. It was established during the investigation that the value of p_{pl} became lower than P_{nas} by 1.0 MPa in some sections of horizon XIV from 1971

through 197[illegible]. The gas saturation of the oil then reached [illegible] m^3/t (according to data of [illegible], Belikhova, 1974). Therefore, the gas was separated in significant amounts.

If the isobar chart of horizon XIV is superimposed on the equal saturation pressure chart, which reflect the maximum decreases of p_{pl} in some sections at different periods of time, with application of well points where shows were recorded, it was established that all the wells in which they were observed fall within locations with value of $p_{sat} - p_{pl} \geq$ [illegible] MPa. Moreover, pure gas initially penetrated the stream in some wells and oil and gas penetrated others, after which the gas, oil and water mixture appeared.

Thus, all the wells in which gas, oil and water shows are observed are divided into two main groups as a function of the incoming bed fluid: 1—wells [illegible], 2031, 3039 and others in which the gas initially penetrated without liquid impurity (Figure 1, first zone). These wells are located in zones where $p_{sat} - p_{pl} \geq$ [illegible] MPa; and 2—wells 3412, 1032, 4007 and others in which an inflow of oil with gas was recorded (Figure 1, second zone). This group of wells is located in a zone with $p_{sat} - p_{pl} =$ [illegible]-[illegible] MPa. This situation was observed for not more than three months.

The mechanism of formation of AVPD zones in them was established for successful forecasting of gas, oil and water shows and thus timely prevention of them, besides separation of the zones of formation of local gas caps. Charts of variation of the effective oil-saturated mass and variation of the permeability of horizon XIV were used for this. As a result, it was established that all wells with shows are confined to regions with reduced oil-saturated mass and permeability in the direction from the ejection wells to bed fluid sampling zones. The largest number of these wells (wells 400, 3412, 4007, 1770 and 1032) are located in regions with clearly marked reduction of the oil-saturated mass by 10 meters or more (see Figure 1). The mud content increases in this case and the average permeability of productive horizons decreases to 100 mD or below (Figure 2).

The occurrence of AVPD under these conditions is explained by the following. Water injected into the intervals with increased permeability moves to the zones of least resistance, i.e., of increased permeability. Conditions for formation of shielded zones with difficult ejection of oil are created in beds whose average permeability is below 100 mD. With increased mud content and special physical properties of the oil (high paraffin content and viscosity and low flowability), this leads to formation of lithological traps in which AVPD are also created.

The gas was separated from the oil in zones favorable for formation of lithological traps. Gas accumulations could be extracted through recovery wells, but this does not occur, which confirms the presence of lithological shields. The bed fluid enters the drilled wells which are located in these very zones of local lithological traps with gas accumulations, where AVPD are created by injection of water into productive beds.

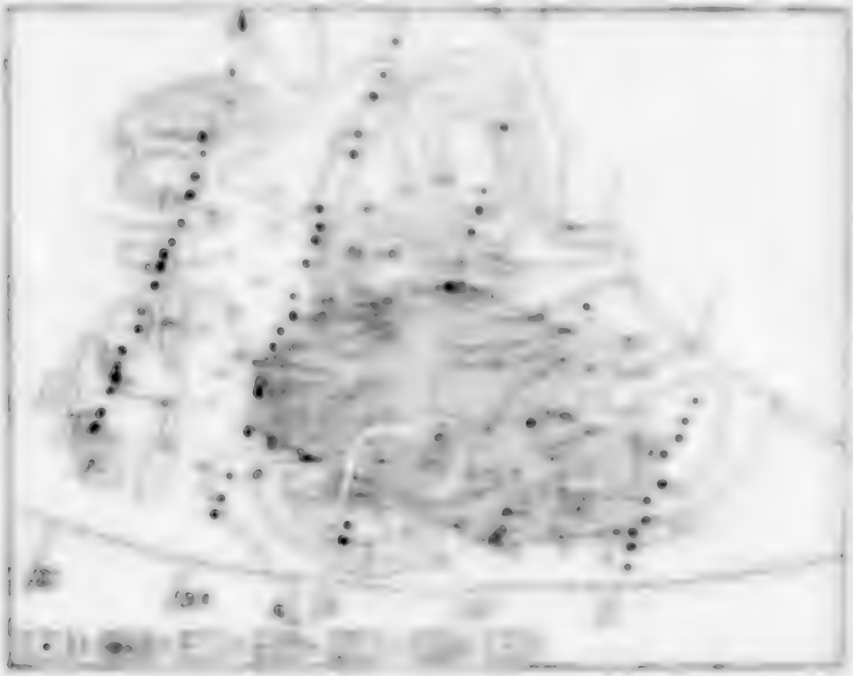

Figure 2. Chart of Variation of Permeability of Horizon XIV of the Southeastern Part of the Uzen' Field (According to Data of KazNIPIneft', 1973): 1 and 2--ejection wells and wells in which gas, oil and water shows, respectively, are observed; 3--outer oil-bearing profile; 4--permeability isolines; 5--ejection series; 6--zone of possible shows upon tapping of horizon XIV; 7--wells drilled without shows

Based on investigations, a zone of possible shows on the southeastern limb of the Uzen' field was designated (see Figure 2). If it is assumed that the well is located in this zone and that there are AVPD in a radius of 500 meters from it, no drilling is begun without implementation of preventive measures to prevent shows. A decrease of p_{pl} in the drilling region to a value close to hydrodynamic is included in the plan by shutting down ejection wells operating on "gravity flow" and by proper selection of the drilling mud parameters and careful monitoring of their variation. Moreover, drilling is carried out by the rotary method.

Conclusions

1. A decrease of p_{pl} below p_{sat} of exploited inhomogeneous oil horizons leads to separation of gas from the oil with formation of local gas caps in lithological traps, the AVPD in which are created as a result of flooding.

2. After the reasons which lead to gas, oil and water shows during well drilling under conditions of flooding inhomogeneous productive horizons are established, they can be predicted and preventive measures can be implemented.

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[illegible]

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FORECASTING GAS, OIL, WATER SHOWS

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 11, Nov 79 pp 54-56

[Article by N. A. Shudhiev, Usen' UBR]

[Text] Gas, oil and water shows which are mainly encountered when tapping horizons if the bed pressure p_{pl} is higher than expected are possible when drilling wells in oil fields using intrazonal flooding. Gas, oil and water shows have been observed since 1972 at the Usen' field--since the beginning of intensive pumping of water into the oil horizons. More than [illegible] of these complications were recorded during the period 1972-1976 as a result of the fact that the productive beds were drilled out, being oriented toward previously obtained data on the value of p_{pl} determined once every quarter on an isobar chart. The actual value of p_{pl} was [illegible] times higher than hydrostatic pressure (the shows sometimes passed into the discharges of bed fluid). Data on the drillability of rock* are used to prevent gas, oil and water shows.

Known methods of elimination--making the drilling mud thicker, which frequently leads to absorption since the overlying strata have low hydrorupture gradients ([illegible]), [illegible] and cementation of showing levels--are used at the beginning of their currents. Moreover, they are sometimes used alternately, but unsuccessfully. Thus, wells [illegible] and [illegible] had to be eliminated due to the impossibility of timely crushing of the showing bed. Forecasting of shows was made difficult due to the significant geological inhomogeneity of the productive horizons in which zones of abnormally high bed pressures (AVPD) are formed as a result of flooding. Many funds and much time were expended to eliminate the occurring complications.

Study of the mechanism of AVPD zone formation during flooding of productive horizons permits successful prevention of gas, oil and water shows. If the characteristics inherent to occurrence of shows are analyzed, the following can be noted:

* [illegible] Chudnovskiy, [illegible] Kolesnikov and Yu. [illegible] Lobanov, "Prevention of [illegible] Oil, Gas and Water Shows in the Usen' Area Using Data on the Drillability of Rock," NTS BURENIYE, No [illegible], Moscow, VNIIOENG, 1977, pp [illegible]

Prior investigations of [illegible] scientific research institute of the Petroleum Industry), [illegible] and the Tyumen State Polytechnic University proved the capability of hydrophobization of the clay fraction of drilling mud with montmorillonite filler. The extent of adsorption in [illegible] clay powder has nearly a constant value, while variation of the potential of particles permits one to assume a physical [illegible] nature of adsorption. If one percent GKZh-11 is introduced to 1.5 percent aqueous suspension of clay powder, the specific surface was reduced from [illegible] to 24 m^2/g. A further increase of GKZh-11 content hardly reduces the specific surface. Investigation of the bentonite dispersion process of the [illegible] field in water and in aqueous solution of GKZh-11 in a concentration of [illegible] percent showed that a reduction of swelling of the clay and suppression of dispersion occur simultaneously with the clay hydrophobization process (the particle size of the suspension increases from [illegible] to 15 microns).

Stabilizer reagents which combine readily with GKZh-11 were selected to produce high-quality drilling mud with stable indicators. The best results were obtained when cellulose ethers ([illegible]) and lignosulfonates (KSSB) were used as the stabilizers.

Active hydrophobization of the clay material predetermined investigations to study the friction forces of the tools in the column of a simulated well during drilling and [illegible] operations with mud treated with GKZh-11 and one of the stabilizers (KMTs and KSSB). The investigations were conducted on a special stand which simulates well conditions [illegible]. It was established that the wettability of the drilling mud with additive of [illegible] percent GKZh-11 corresponds to introduction of 10-15 percent oil and the contact time of the tool with the clay crust has no appreciable effect on the value of resistance.

Based on conditions of the best wettability and hydrophobization, the optimum GKZh-11 content in the drilling mud comprises [illegible] percent, which can be checked indirectly for tackiness on the [illegible] device (an angle of [illegible] degrees corresponds to optimum GKZh concentration).

The analyses permitted recommendation of a recipe of drilling mud with GKZh-11 and stabilizers for commercial introduction. The technology of preparing the mud at the drill rig reduces to introduction of GKZh-11 to the circulating water prior to the beginning of drilling from under the [illegible] and subsequent stabilization. Conditions are created in this case for use of it as a regulator of the solid phase content in the drilling mud. The consumption for the first treatment comprises [illegible] percent GKZh-11 and [illegible] percent KMTs. The stabilizer is subsequently introduced at a rate of [illegible] percent every 200-300 meters of drilling.

The recommended formula completely excludes the use of oil for treatment, reduces the variety of reagents used by two and considerably simplifies utilization of drilling mud after completion of well construction.

A total of [illegible] wells was drilled in the fields of the central Ob' region using this formula. There were absolutely no complications during drilling of all the wells caused by previous use of incompatible muds even if the [illegible] were immobile up to [illegible] hours and at well [illegible] for [illegible] hours. The rate of [illegible] of the natural clay mud was reduced by a factor of five. The saving comprised two million rubles for these wells due to economizing on chemical reagents alone (expenditures for utilization of drilling mud and environmental protection were not taken into account in the calculation).

Thus, the investigations permit recommendation of the formula of natural clay mud on a base of organosilicon compounds, lignosulfonates and cellulose esters for extensive use.

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2. [illegible], [illegible], [illegible], [illegible], [illegible] et al., "The Lubrication Properties of Drilling Muds with [illegible] Additives," NTS. SERIYA BURENIYE, No 1, Moscow, VNIIOENG, [illegible].

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UDC 622.24.063.002.[illegible]

NEW LABORATORY FOR OPERATIONAL CHECKING OF DRILLING-MUD QUALITY

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 11, Nov 79 pp [illegible]

[Article by V. [illegible] Karmolis, SPKB Promavtomatika]

[Text] Quality control of drilling mud parameters is impossible without a complex of devices and installations which provide the required accuracy of determination and which meet unified technical regulations for conducting well-drilling operations. It has become necessary in this regard to develop new and to modernize old apparatus. The KBR drilling complex and the KLR laboratory complex*, industrial output of which has been organized at the BPZ, were developed in 1977 by VNIIKAneftegaz (All-Union Scientific Research, Planning and Design Institute of Complex Automation in the Petroleum and Gas Industry) jointly with the Baku Instrument Building Plant (BPZ).

In 1977, SPKB (Special Planning and Design Office) Promavtomatika and BPZ developed the PLL-1 self-propelled drilling mud laboratory for operational quality control of drilling mud, selection of the formula, the chemical treatment conditions and increasing the weight.

The laboratory contains a VSN-3 rotary viscosimeter, [illegible] balances, VRP-1 density meter, PGR-1 gas content device, FLR-1 filter press, VBR-1 viscosimeter, OM-2 settling tank, [illegible] chemical compartment, TTR-1 installation, [illegible] tester, LMR-1 laboratory stirrer, VLT-200 commercial scales, the Elektronika electric typewriter and a set of auxiliary equipment (electric heater, drying cabinet, TV coil with cable, hose for water supply and so on). This complex of devices and equipment is located in the cab of a KAVZ-685 bus.

The PLL-1 laboratory makes it possible to obtain more extensive information on the properties of drilling muds. Thus, the rheological parameters--

* [illegible] Kashenov, [illegible] Boyarinov, [illegible] and Yu. A. Timokhin, "New Sets of Instruments for Checking Drilling Mud Parameters," NTS AVTOMATIZATSIYA I TELEMEKHANIZATSIYA NEFTYANOY PROMYSHLENNOSTI, No 3, Moscow, VNIIOENG, 1977, pp 7-10.

the effective and plastic viscosity, maximum dynamic and static shearing stress of drilling muds may be determined by using the [illegible] viscosimeter, which permits purposeful control of their structural and mechanical properties. The [illegible] filter press is designed to determine the water delivery (water loss) at pressure from 0 to 1 kgf/cm². Use of the [illegible] makes it possible to increase the accuracy of measuring the density of the drilling mud up to ± 0.01 g/cm³. The volumetric content of gas is determined by means of the [illegible] device.

The [illegible] chemical compartment, which is a set of laboratory dishes and chemical reagents, is used to carry out chemical analysis of the filtrate.

The newly developed [illegible] installation is designed to determine the solid phase and oil content in the drilling mud. The operating principle is based on evaporation of the liquid phase from a given volume of drilling mud, condensation of the vapors and measurement of their volume. Structurally, it consists of a thermostat with heat insulation and an evaporator with a condenser and measuring cylinder.

The laboratory contains an [illegible] tester developed by TatNIPIneft' (Tatar Scientific Research and Planning Institute of the Petroleum Industry) and designed to analyze the unit resistance of hydrophobic-emulsion drilling muds, by the value of which the motion stress is taken. The optimum number of emulsifiers and the time of preparation of the emulsion solutions can be established under field conditions when using it.

The [illegible] laboratory stirrer provides for mixing of the mud sample ([illegible] cm³) at a [illegible] rotational speed of 1,000 rpm and provides automatic shutoff every three minutes of operation.

A laboratory desk on whose left end there is a basin with a water barrel and to the right end of which is attached the [illegible] laboratory stirrer, has been installed on the left side of the bus. A collapsible working table has been installed between the laboratory table and the driver's seat. Two chairs and a sofa for colleagues of the mud management service are located on the right side.

The devices and installations contained in the laboratory are placed in the laboratory desk on special platforms and are firmly secured during transportation. The auxiliary equipment and spare parts for the bus are located in the drawer of the sofa.

The equipment of the bus ensures convenience and comfort of the service personnel. The air is heated in it during winter.

The [illegible] laboratory successfully passed interagency trials and industrial output of it in place of the [illegible] laboratory has been organized at the [illegible].

UDC 622.276.012:69.057.13[illegible]

CAPITAL CONSTRUCTION PROBLEMS IN OIL INDUSTRY REVIEWED

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 1, Jan 80 pp 3-6

[Article by Sh. S. Dongaryan, deputy minister of the petroleum industry: "Problems of Raising the Efficiency of Capital Construction"]

> [Text] "Speed, economy, and an up-to-date technical base are the components of high efficiency in capital construction" (L. I. Brezhnev).

Successful development of the petroleum industry is significantly linked to raising the efficiency of capital construction, increasing labor productivity in construction, and improving the operating indexes of the facilities constructed. Solving these problems should be the goal of the measures being taken in the Ministry of the Petroleum Industry following the decree of the CPSU Central Committee and USSR Council of Ministers entitled "Improving Planning and Strengthening the Influence of the Economic Mechanism on Raising Production Efficiency and Work Quality."

In the Tenth Five-Year Plan petroleum industry facilities are being built under more complex conditions, primarily because the industry continues its march into regions with harsher natural and climatic conditions. In the near future it will be necessary not just to enlarge the scale of building at new deposits and construction of trunk pipelines and other installations, but also to increase the volume of work on modernization and expansion of existing enterprises, technological re-equipping of them, and further automation of industrial processes.

As a result, the Ministry of the Petroleum Industry faces the major challenge of sharply raising the efficiency of capital construction and stepping up the launching of production capacities and facilities. Normative times for launching production capacities and significant increases in construction times are still common, which

enlarges the volume of incomplete construction, immobilizes capital investments, and reduces the efficiency of petroleum production. An analysis made by VNIIOENG (All-Union Scientific Research Institute of Management Organization and Economics of Petroleum and Gas Industry) of 1,000 start-up production complexes and facilities shows that for some of them the actual time of construction is more than double the normative time. Even at projects done with a high degree of factory readiness, for example using modular clustered pumping stations, the actual construction times are almost triple the normative figures.

The large scale of capital construction in the petroleum industry demands special care in economic substantiation in planning decisions being reached and in choosing where to apply capital investment. Growth in the efficiency of all petroleum production depends greatly on the progressiveness and level of economic substantiation of planning and design decisions being developed and made in the area of capital construction. Studies of the time lag in undertaking capital projects in new regions show that up to eight years is required for the construction and establishment of the regional infrastructure to support the beginning of industrial exploitation.

The current phase of development of petroleum production in the country makes it urgent to sharply curtail the entire investment cycle for launching new capacities and facilities in operation. This can only be done on the basis of the systems approach to improving all stages of the investment process in the sector, including surveying, designing, construction proper, and incorporation of production capacities.

Of the immediate problems in this area the most important is working out a system of long-range (10-15 years), medium-range (five years), and current (annual) planning of capital construction and application of capital investment. In conformity with the above-mentioned decree of the CPSU Central Committee and USSR Council of Ministers, the plans should be based on the principle of balancing the needs of the sector for construction organization capacities, resources, and material-technical base of construction.

A significant amount of construction and installation in the petroleum sector is being done by personnel of the sector itself. The volume of this work will grow steadily in the future because of the specific characteristics of the development of and construction at petroleum deposits. For this reason a clear delineation must be made of the types of jobs and projects to be turned over to contracting construction ministries and those to be done by the petroleum ministry's own personnel. The differentiation of construction and installation jobs by performers should insure high efficiency of capital construction and petroleum production.

The sector has not yet resolved the problems of optimizing the application of capital investment by forms of reproduction (new construction, expansion, reconstruction, and technical re-equipping). The lack of balance in production capacities limits the possibility of planning new construction, especially in old regions. A balance and calculation of production capacities and facilities by the above-listed forms of reproduction should be reflected in plans for capital investment.

In questions related to working out the general principles of organizing the spread-out form of construction characteristic of oil field and pipeline facilities, widespread techniques (rigid models) based on attempts to formulate uniform principles and recommendations for all petroleum regions of the country should be rejected. It is better to base the method of planning capital investment on the principle of a balance of production capacities, including construction capacities, considering that under conditions of dispersed, locally-based construction of oil fields, petroleum transport, and gas refining construction, construction organizations must have certain autonomy and flexibility, with both highly productive equipment and mobile production enterprises.

The growing complexity of sectorial and intersectorial ties makes the problem of coordinating the actions of all participants in the investment process, determining rational forms of interaction among them, and orienting them toward final results especially critical.

A significant rise in the efficiency of capital investment is only possible on the basis of broad use of scientific-technical advances and changing the construction site to an installation site. With the Ministry of Chemical and Petroleum Machine Building, the Ministry of Instrument Making, Automation Equipment, and Control Systems, the Ministry of Construction of Petroleum and Gas Industry Enterprises, and other ministries and departments, for almost 15 years the Ministry of the Petroleum Industry has been working in planned fashion to raise the level of industrialization of construction on the basis of the modular unit method of building petroleum industry facilities. This technique is a multifaceted one. It includes refinement of design concepts and the technology of industrial and construction production and transportation of modular set units and creates prerequisites for more progressive methods of operating and repairing such facilities during operations. The comprehensive character also insures a decrease in expenditures of material-technical and labor resources not just in construction and operation of the petroleum facilities, but in the national economy as a whole. These advantages of the method made it the primary one in construction of oil field facilities and trunk pipeline installations.

Standardization of technological, design, and space planning concepts is an important condition for realizing the advantages of the modular unit method of construction. The leading institutes of the Ministry of the Petroleum Industry have worked out a classification of petroleum extraction enterprises which defines the criteria that regulate the extent of rational use of single-pipe transport and location of booster pumping plants, central petroleum, gas, and water collection and preparation points, and other structures, and conditions for shaping the collector systems of the petroleum extraction region. Sectorial standards have been developed and introduced for parametric series of primary modular automated equipment for production complexes at petroleum deposits. In addition standards have been introduced for the reliability of modular automated equipment and for the development, manufacture, design, and operation of facilities using modular automated equipment. The guideline document "Standardized Technological Schemes for the Petroleum, Gas, and Water Collector and Preparation Complexes of Petroleum Extraction Regions" has been adopted and put into effect.

Giprovostokneft' [State Research and Planning Institute of the Petroleum Extraction Industry of the Eastern Regions of the USSR] used these guideline documents as the basis of its work to make up full-cycle industrial complexes to be delivered for construction and installation at oil fields.

Under the conditions of Western Siberia, using the supermodules developed in creative cooperation with Giprotyumenneftegaz [possibly State Planning Institute for Petroleum and Gas Industry Development in the Tyumen' Region], Sibkomplektmontazh [possibly Siberian Administration for Installation of Complete Sets of Equipment], and other organizations, makes it possible to reduce the number of construction workers 4-7 times and cut the prime cost of work to build the ground part of modular set units by 30-32 percent. Plans for the future envision enlarging the unit weight of these modular set units to 1,000 tons and more, which will increase the economic efficiency of their use. Giprotruboprovod [State Institute for the Planning of Trunk Pipelines] has formulated a plan for the modular-type BMNPS-12.5 petroleum pumping station for trunk pipeline transportation. It has better indexes than the pumping plants now being built.

However, the volume of production of modular set units and, in particular, the assortments still do not meet the needs of the petroleum industry. The situation is particularly difficult with auxiliary industrial and engineering support facilities, material-technical supply systems, transportation systems, and worker supply administrations, specifically housing and domestic service modules for tour-of-duty ("vakhta") operations.

The shortage of needed substation modular units prevents comprehensive delivery of all required structures, slowing down the rate of construction and setting back the launching time for production capacities. Moreover, multiple changes in technical decisions on modular set units occur, which cannot be justified economically, and the level of factory readiness of the units delivered by many enterprises is low. Modules are often delivered to the construction sites incomplete and unassembled, and control and measuring instruments and automation equipment are shipped without containers. The manufacturers of the modular set units are not the only ones to blame for this, of course. The necessity of "assembling" equipment at different levels greatly complicates the process of putting together full modular set units. The results of operating these units indicate that questions of quality do not receive adequate attention in any stage from scientific research to manufacture.

Work experience shows that the development and introduction of clustered well drilling, setting up a sealed pressure system for collecting and transporting the output of oil wells, transporting petroleum gas without compressors, transporting gas-saturated petroleum, and other developments by scientific research and planning institutes of the Ministry of the Petroleum Industry has made it possible to create the prerequisites to solve the problems of automating production and protecting the environment. They have promoted concentration and reduction in the number of field structures, thus making it possible to introduce the method of modular set construction and achieve high technical-economic efficiency in building up and exploiting deposits. At the same time, analysis shows that the national economic and sectorial efficiency of the application of this method has been dropping in recent years. The cost of modular set units has risen and the construction time for projects using them has become longer. The same thing is happening here as was observed during the introduction of progressive prefabricated construction components, the introduction of numerous mechanized means of construction, and the application of critical path techniques. At first efficiency was high, but later, despite the progressiveness of the methods, the growth rate dropped off.

This is not always a result of exhaustion of the potential of progressive techniques. Their efficiency often drops because of nonoptimal conditions of application and the inappropriateness of these techniques to the forms of organization and management of their formulation and use. Thus, during the first period of formulation and introduction of the method of modular set construction primary attention was devoted to the development of new modular components, the technology of their production, transportation, and installation. Questions of organization and management were not given proper attention. Established organizational structures, standard legal statutes, and the given system of management were used to incorporate the production of modular set units. As a result, the interests of the developers and clients of the modular set construction method did not always coincide.

let us give examples. The client receives equipment from industry within the funds allocated to it. If modular set units are built on the basis of these funds, the cost of their manufacture at the factory will increase because of additional materials and components which form the were part of construction and installation work. As a result of this, the client will receive fewer units of equipment for the given volume of appropriated funds.

There are also difficulties at design organizations. The labor inputs of designers increase when they are designing modular set units, but these employees are already greatly overloaded and want to reduce the labor-intensiveness of their jobs.

As for construction workers, they experience "plan-report" difficulties because when the modular set technique is used equipment costs are greater and the proportion of construction and installation work is less because modular set units are industrially produced articles. To insure good production indexes and a high ranking for the construction organization, when introducing modular set units the construction worker tries to "run up" the estimate, for example to assess the roof separately from the interior part of the modular unit. The endeavor, which receives planned encouragement, to enlarge the volume of construction and installation work by increasing materials-intensiveness contradicts a progressive process in construction, increase in the share of embodied labor in the volume of capital investment, and hampers improvement in the efficiency of the modular set method of construction.

Other examples of similar conflicts could be given. They all relate to the fact that, under existing rules, norms, statutes, and instructions, participants in the total production cycle of building and using modular set units are not oriented to a common goal, to receiving final national economic results.

This raises the necessity of working out an efficient system for organizational management of the modular unit method of construction. To achieve this a nationwide, comprehensive program should be formulated to insure extensive and efficient use of modular set construction with participation by all involved ministries and departments, the suppliers, contractors, and users of output.

The science-production associations within the systems of the Ministry of Construction of Petroleum and Gas Industry Enterprises, the Ministry of Chemical and Petroleum Machine Building [illegible] the Ministry of the Petroleum Industry that specialize in the [illegible] manufacture and introduction of new types of modular set units, including full sets of equipment for all facilities at gas and oil fields, trunk pumping and compressor plants, and other installations, could become an important

element in the system of organized management of projects according to this method.

The examples we have considered show what a great effect improving the economic mechanism by taking the steps outlined in the decree of the CPSU Central Committee and USSR Council of Ministers should have on the efficiency of practical use of scientific-technical advances in capital construction. The rich experience gained from economic experiments conducted in construction and industry should be taken into account here. It would also be wise for the field of capital construction to make use of the progressive practices developed by the Ministry of the Electrical Equipment Industry and other ministries in formulating a comprehensive sectorial system for management of scientific-technical progress.

At the same time, development of new ways to improve the modular set method of construction in the petroleum industry does not exhaust the full range of problems involved with raising the efficiency of capital construction. There must be a systems approach encompassing all spheres of capital construction of petroleum industry facilities, not just ground construction, which is what this particular method handles. As domestic and foreign experience shows, this problem can be solved by the use of the target program method based on the systems approach. In 1979 VNIIOENG worked out a model target program for improving the system of capital construction for the 11th and 12th five-year plans.[1]

The development and implementation of steps toward systematic improvement in the development of capital construction using progressive new technical, technological, and organizational concepts, including the modular set method of construction, will make it possible to raise the efficiency of capital construction and quality of its output significantly.

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[1] Dongaryan, [illegible], "Furthering the Industrialization of Construction of Petroleum Industry Installations" NEFTYANOYE KHOZYAYSTVO [illegible], No 9, pp [illegible].

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RESULTS OF FIELD TESTS OF CYCLICAL FLOODING IN TATARIA, SIBERIA REPORTED

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 1, Jan 84 pp [illegible]

[Article by [illegible] S. Sharbatova, VNII: "The Application of Cyclical Flooding at Deposits in the Tatar ASSR and Western Siberia"]

[Text] Cyclical flooding is used on a large scale at many petroleum deposits in the Soviet Union. In Western Siberia this technique was first introduced in 1970 at the Trekhozernoye deposit, and then in 1971 at the Mortym'ya-Teterevskoye deposit [1, 2].

In 1970-1971 VNII (All-Union Scientific Research Institute of Petroleum and Gas) together with Giprotyumenneftegaz (possibly State Planning Institute for Petroleum and Gas Industry Development in the Tyumen' Region) and the corresponding NGDU's (petroleum and gas extraction administrations) wrote up the first program for conducting industrial testing of cyclical flooding in sectors of the Mortym'ya-Teterevskoye, West Surgut, Ust'-Balyk, and Samotlor deposits. At the Mamontovskoye deposit industrial introduction of the technique is being done according to a technological scheme drawn up by VNII and SibNIINP (possibly Siberian Scientific Research Institute of Petroleum and Gas) in 19[illegible] for layer $B_{[illegible]}$. In all, the method is being used in sectors of 14 deposits in Western Siberia.

In the Tatar ASSR the first tests of the method were begun in 1972 in the central sector of the South Romashkinskoye site of the Romashkinskoye deposit following a program written by VNII and TatNIPIneft' (Tatar ASSR State Scientific Research and Planning Institute of the Petroleum Industry). Work was stopped for technical reasons in late 197[illegible], but the positive results of the test made it possible to move on to broader testing of the techniques.

Industrial testing work was also begun in 1972 at sectors of the East Suleyev and Al'keyevskiy sites, and then in 197[illegible] at the Aznakayevo and [illegible]-Aminovskoye [3] sites according to program plans drawn up by VNII and the corresponding NGDU's.

The program and technological schemes for conducting cyclical flooding, substantiated conditions for performance of industrial testing, selection of the optimal regime of nonstationary influence, and conditions for evaluating the efficiency of the process. These matters were subsequently elaborated in the "Manual on Application of the Cyclical Flooding Technique" (1983) and in work [6].

Considering that the proposed tests were basically experimental, primary attention was devoted to establishing conditions for conducting the process which would provide the most reliable evaluation of the potential of the technique. One of the main conditions was maintaining the volume of pumping water necessary for conventional flooding during the conduct of experimental projects, because when this condition is violated it is hard to compare indexes of the two types of flooding.

With an increase in the average level of pumping the resulting growth in petroleum extraction can be explained not only by the action of elastic capillary forces but also by the increase in the amount of injection pressure. In view of the need to obtain data for evaluating the effectiveness of cyclical flooding, conducting the experiment with a lowered average level of injection should be considered a preferable alternative.

Maintaining a steady regime of exploitation of oil wells is also an important condition. The sector in which application of the method is planned must have been completely drilled and exploited for a certain time by conventional flooding. In other words, the existing wells must be producing stably. The well equipment (productivity of pumps, pipe connections, and the like) should not be changed for 1-2 months (a time sufficient to stabilize the operating regime of producing wells in the sector) before the beginning of the experiment and as long as it lasts.

The prerequisites for ensuring stability in existing producing wells and their operating regime are usually formulated at the stage of planning industrial testing projects by choosing sectors in which these requirements are feasible.

Compliance with these conditions will make it possible to obtain data that is sufficiently authentic for a reliable evaluation of the potential of the method.

Meeting the first condition depends entirely on organization of the process and is most difficult. It is advisable to maintain the assigned pumping regime (keep the average level of injection unchanged) and insure maximum possible fluctuations of pressure in the layer by dividing the series of injection wells into roughly equal groups and injecting water from them in different phases.

Two variations of injection are possible here:

1. Creation of fluctuation in the flow rate relative to an average level for each group of wells. In this case pumping should be organized so that adjacent elements have opposite phases of flow rate for the injected agent. An excess of pumping in one phase should be compensated for by a decrease in the second phase with all injection wells operating without stopping.

2. Alternating work by equal groups of injection wells with a corresponding increase in the acceleration of the working wells. In this case during a symmetrical cycle when the length of pumping for a group of wells is equal to half the cycle of cessation of pumping, the volume of water injected during the period of well work should be doubled. With an unsymmetrical cycle when the length of the period of pumping is greater than the period of cessation for the group of wells (this is how [illegible] pumping is done at many Western Siberian deposits), the increase in the volume of injected fluid during the period of higher injection pressure should be $K = T/t_n$ (T is the time of a cycle, t_n is the injection time).

The equipment of [illegible] (maintenance of reservoir pressure) [representing] systems, both in Western Siberia and the Tatar ASSR, allows an average increase in pumping of [illegible] percent. Thus, where the length of a cycle is [illegible] days, for example, the phase in which the groups of injection wells is fully switched off should not be less than [illegible] days.

The period of nonstationary influence on the deposit may differ according to the specific geological conditions and is calculated with due regard for the elasticity characteristics of the collector and well grid. The length of this period should be sufficient to complete the redistribution of base pressure and processes of capillary impregnation which insure keeping the maximum amount of water in the layer [illegible].

The first variation was recommended in most cases when drawing up the program for conducting cyclical flooding experiments. It was assumed that a periodic injection regime should be assigned by alternating change in the flow rate of the injected fluid for neighboring groups of wells with an amplitude of half of the average pumping level for conventional flooding and half-cycles of roughly equal duration.

The table below gives the primary factual data on industrial testing of cyclical flooding at [illegible] sectors of deposits in Western Siberia and the Tatar ASSR. For various technical reasons, the actual industrial testing differed from that envisioned by the program.

For example, the calculated full period of influence for layer [illegible] in the West Surgut deposit is [illegible] days, while for layer [illegible] it is [illegible] days. In reality (refer to the table), the full period in most cases

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* In the half-cycle of reduction in pumping the injection wells are discontinued.
** By the date of efficiency evaluation flooded wells were missing from those analyzed.

Key: (a) Deposit, State; (b) Objects at Which Work Regime Was Changed; (c) Horizon, Level;
[Key continued, next page]

Key (continued)

(d) Year of Launching in Operation;
(e) Year of Beginning of Cyclical Flooding;
(f) Actual Duration of Pumping Half-Cycle, days;
(g) Increase;
(h) Decrease;
(i) Number of Wells at Which Impact Was Evaluated;
(j) Volume of Pumping During Periods of Cyclical Flooding as Percentage of Volume During Period of Conventional Flooding;
(k) Cumulative Additional Petroleum Extraction During Application of the Technique, thousands of tons;
(l) Wells Stopped Before the Year;
(m) Pumping Limited in the Year.

[Numbered entries below include half-name of deposit or site (a) and identification of objects at which work regime was changed (b).]

(1) Mortym'ya-Teterevskoye, sectors III + IV;
(2) East Teterevskoye, sectors I + II;
(3) South Teterevskoye, sectors I + II;
(4) [illegible], wells 1206, 1210, 1208, and 303;
(5) Trekhozernoye, cluster pumping plants II + IV;
(6) Mamontovskoye, cross-cutting row VI (cluster pumping plants Nos 1 + 2);
(7) Sovetskoye (right bank, wells 551-650);
(8) Pravdinskoye, cluster pumping plant No 1;
(9) West Surgut, cluster pumping plant No 1-4;
(10) Same as above;
(11) Ust'-Balyk, wells 275, 276, 277, 278, 279;
(12) Sovetskoye (right bank), cluster pumping plants Nos 11 + 12;
(13) Vatinskoye, cluster pumping plants Nos 1, 2, 4;
(14) Megion, cluster pumping plants Nos 1, 2, 3;
(15) Samotlor, southeastern sector, cross-cutting row IV and V;
(16) Samotlor, northwestern sector, cross-cutting row III;
(17) [illegible], cross-cutting row V;
(18) Abdrakhmanovskoye, block I;
(19) Abdrakhmanovskoye, sector I;
(20) Abdrakhmanovskoye, sector II;
(21) Abdrakhmanovskoye, sectors III + IV;
(22) Abdrakhmanovskoye, sectors V + VI;
(23) Abdrakhmanovskoye, sectors VII + VIII.

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averaged 77 days. The volume of injection was increased for 77 days for one group of wells, while for 17 days the other group of injection wells was disconnected. Thus, the lower [illegible], the length of the actual period, which is greater than the calculated figure, may be

considered adequate to accomplish elastic and capillary processes in the layer associated with fluctuations in layer pressure. But under the conditions of layer [illegible], the length of the phase of lowering layer pressure should be increased by an average of 10 days.

At the Romashkinskoye deposit the frequency of phase changes generally corresponds to the calculated frequency. A minor deviation of frequency characteristics from assigned figures was observed in sectors of the Almetyevsk site (the half-periods were sometimes [illegible] days compared to the calculated [illegible] days).

The frequency and amplitude of the influence are two interrelated parameters. If one of them does not correspond to predicted values there will be a failure to meet the main principle of conducting industrial experiments because the condition of maintaining average pumping volumes at programmed levels will be violated. The actual amplitude factor differed from that adopted in the program in many of the installations studied.

At almost all sectors of the [illegible] and Surgut oil fields cyclical pumping was achieved by alternately disconnecting groups of injection wells. However, during the half-cycles when injection pressure was increasing the losses in pumping occurring because of limiting during the half-cycle of lowering layer pressure were not completely made up. For this reason the average amount of water pumped for the sectors was [illegible] percent of the amount pumped under cyclical flooding. At sectors of the Romashkinskoye deposit the volume of water injected during the period of industrial testing was [illegible] percent of the prescribed flooding volume for this same reason.

The process of forming groups of injection wells working in different phases was done differently at the testing sites. The grouping of wells depends on the system of exploitation of the deposit and its level of activity [5]. The number of wells in a group (element) is determined with due regard for the construction plan of the deposit and the maximum possible effective influence on the mobile pressure front. It is advisable to include [illegible] injection wells in each group, which is typical of some sectors of West Siberian deposits. At the same time other deposits such as [illegible], [illegible], and [illegible] have injection wells with opposite flow phases in an alternating arrangement in the cross-cutting row.

This organization of the process justifies itself only in the initial stage of exploitation of the deposit when the first rows of producing wells are in full operation (at this time the injection wells have usually been incorporated for pumping on an alternate, every-other-one basis). Later when the wells of the first producing rows reach maximum flooding and are taken out of production, cyclical pumping into the wells on an every-other-one basis with the chosen amplitudes of

fluctuations in flow rate may prove ineffective for more remote producing wells.

The zone of impact of the method can be expanded to 2-3 producing rows by a significant increase in the amount of water being injected within the operative plan for conduct of the processes or switching to grouping wells with an alternate pumping regime. The latter technique was used at sectors of the Romashkinskoye deposit where injection rows were fully incorporated for flooding.

In most cases the actual process of cyclical flooding involved a decrease in the average level of pumping compared to the period before. The evaluation of the effectiveness of the process of cyclical flooding, taking into account existing deviations from program recommendations, was made according to the well-known methodology of works [5, 6]. The results are presented in the table.

For the sectors analyzed it is not possible to establish a dependence of absolute or average growth in extraction on the degree of change in pumping volume compared to the preceding period. The only thing established was that a decrease in average pumping level to 70-80 percent of the initial level is the chief cause of ineffectiveness for the process.

At the same time, at sectors where growth in extraction was achieved, a decrease in its rate over time is observed. Figure 1 below shows the change in growth of additional petroleum extraction over time at Block 7 of the Abdrakhmanovskaya site. A similar relationship is observed for other sectors. One of the reasons may be that, given inadequate levels of water pumping and amplitudes of fluctuation in layer pressure, the cyclical process does not provide the necessary degree of influence on wells in distant rows.

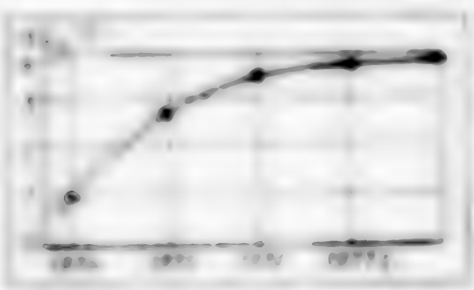

Figure 1. Dependence of Cumulative Additional Petroleum Extraction Q_{ad} on Time of Exploitation t for Block 7 of the Abdrakhmanovskaya Site.

Despite difficulties analyzing the results of cyclical flooding because there were deviations from program conditions, Figure 2 shows that it is possible to obtain a relationship between the absolute and average annual growth in extraction and the length of exploitation of sectors with conventional flooding preceding cyclical flooding.

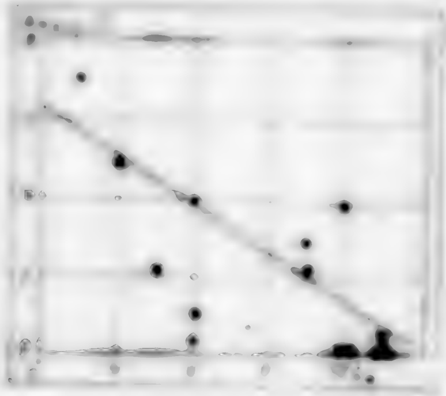

Figure 2. Dependence of Additional Average Annual Petroleum Extraction ([illegible]) on Length of Exploitation of Deposit Before Cyclical Flooding ([illegible])

Figure 2 shows installations at which the average level of pumping did not go below 60 percent. A trend is observed toward increase in effectiveness of the process with a decrease in the period of preceding exploitation. It is noteworthy that minimum or zero growth in petroleum extraction occurred at all installations which had been exploited for more than 10 years before cyclical flooding. Therefore, the use of cyclical flooding in the early stage is more effective, which agrees well with theoretical studies made by the VNII methodology [4].

In the Tatar ASSR additional extraction from cyclical flooding was obtained for three sectors where the process was begun 13-20 years after the beginning of exploitation. It is possible that this has to do with differences in the nature of the collector in the region and with a higher initial petroleum saturation. This question needs further study.

The effect of the process of cyclical flooding on increase of the exploitation of individual producing wells drilled at different times before the experimental projects was analyzed for certain sites. The results of the analysis for one of the sectors ([illegible] site in Western Siberia) are presented in Figure 3, from which it can be seen that the effectiveness of the process increases with a decrease in the period of well operations before cyclical flooding.

Figure 3. Dependence of Effectiveness of the Process of Cyclical Flooding Δq_c on Time t of Launching Wells Into Operation at the Right-Bank Solkinskoye Site (1, 2 Represent, Respectively, Wells at Which Effectiveness was Evaluated on 1 January 1976 — 1,063 Wells, and 1 January 1977 — 661 Wells)

Conclusions

1. Industrial testing of cyclical flooding involves significant deviations from program conditions. The principal difference is a decrease, at most sites, in average levels of water injected compared with levels before the start of the process. This is because of failure to maintain amplitude and frequency characteristics.

2. Despite the discrepancies between program and actual conditions of conducting the process, switching to cyclical flooding at experimental sites in West Siberia produced an average additional yield of 676,600 tons of petroleum for three years. At the same time the conservation of pumping water is 1,537,600 cubic meters. Corresponding figures for sectors in the Tatar ASSR were 136,000 tons and 448,100 cubic meters.

3. The effectiveness of cyclical flooding diminishes with an increase in the length of time that the well was operated by conventional flooding before the test. The effect of this factor may vary depending on the characteristics of reservoirs.

4. The results of the tests provide substantiation for broad use of the method of cyclical flooding on an industrial scale. At the same

time. Further field study is needed to identify the geological and industrial conditions that foster maximum effectiveness of the technique and to clarify causes of inadequate effectiveness at certain test sites.

FOOTNOTES

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4. Gorbunov, A. T., Mukhtarvants, S. A., Safronov, S. I., et al., "Cyclical Flooding of Petroleum Layers" SER. NEFTEPROMYSLOVOYE DELO Moscow VNIIOENG 1977, No 5.

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RESULTS REPORTED FROM STUDY OF PUMPING EFFICIENCY FOR DEEP WELLS

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 1, Jan 86 pp 32-35

[Article by G. I. Nikolayev, Bashkir ASSR Oblast Committee of the CPSU, S. A. Urazakov, Bashkir ASSR Scientific Research and Planning Institute of the Petroleum Industry, and M. D. Valeyev, VNIISPTneft': "Improving the Use of Slant and Flooded Deep Pumping Wells"]

[Text] The progressively greater flooding of productive horizons and increase in the number of directional wells typical of the conditions of exploitation of the petroleum deposits in the Bashkir ASSR and West Siberia necessitate thorough studies of the relationship between these factors and the operation of pumping equipment.

Analysis of the condition of deep pumping devices now in use shows that the most interesting subject is identifiying the nature of distribution of loads over the length of a column of rods, especially in directional wells. However, our picture of the processes taking place in the column of rods and the pump-compressor pipe is not very clear.

Experimental studies of these phenomena during the operation of deep pumping wells were made at an industrial testing stand devised by the Bashkir ASSR Scientific Research and Planning Institute of the Petroleum Industry and the Aksakovneft' NGDU [Petroleum-Gas Extraction Administration]. It consisted of well No 116, which is practically vertical, and well No 53 with a maximum slant angle of 20 degrees and displacement of the face 230 meters from the vertical, plus two meters for layer water and petroleum, connecting pipe, and measuring equipment. The wells and meters were interconnected as shown in Figure 1 below, which made it possible using shut-off gates 8 and the Boltzmann counter 7 to let petroleum and water in different ratios out of the meters 1 into the space outside the pipe 5 of the well.

The physicochemical properties of the media being pumped out were changed over a broad range during the study by overlapping the

Figure [illegible]. Schematic Diagram of Industrial Testing Stand

Key: (1)	Meter;	(6)	Measuring Apparatus;
(2)	Pressure Gages;	(7)	Space Outside Pipe;
(3)	Pipes;	(8)	Shut-Off Gate;
(4)	Sampling Tap;	(9)	Remote Pressure Sensor;
(5)	Boltmann Counter;	(10)	To Collector.

intervals of well perforation with packers. Model pressure gages 2 and mouth fittings equipped with a sampling tap 4 were installed on the outgoing line to monitor pressure at the mouth. Both wells had the same kind of equipment: 7SK-8-3.5-4000 rockers and NGN2-43 deep sucker-rod pumps suspended at a depth of 1,000 meters. Pipes 73 millimeters in diameter and a combination of rods with diameters of 22 and 19 millimeters were lowered into the wells. EP-1 depth recorders were used to determine the dynamic level. The load on the balancer head was recorded by a GDM-3 dynamograph. Degassed Devonian oil and layer water with densities of, respectively, 0.86 and 1.172 grams per cubic centimeter were used in the experiment.

To study the mechanics of the process of raising fluid, pressures in pumping pipes were recorded in well No 31 at depths of 0, 390, and 1,000 meters and at depths of 0, 390, 500, 700, and 1,000 meters in well No 116. The pressure in the column of pumping pipes was measured by means of special couplings equipped with remote tensometric

sensors 5, from which information was fed to the surface by cable. Measuring apparatus 6 consisted of an MPI-1 multichannel control console and the above-mentioned pressure sensors, which were developed jointly with VNIIGIS [All-Union Scientific Research Institute of [remainder of expansion unknown]]. An N-13[illegible] automatic recording electronic potentiometer and a loop oscillograph to back it up were used as pressure recorders.

As a result of the tests barograms in the pipes were obtained for the cycle of work of deep sucker-rod pumps in different regimes with different water-oil ratios (including water-free oil and layer water). During the experiments liquid in calculated proportions was fed to the intake of the pumps and after lifting again forced into the space outside the pipe. As studies conducted earlier had shown, the formation of an emulsion begins at the pump intake and is completed in a certain segment of the pump-compressor pipe. The length of the segment in which the viscous properties of the emulsions changed depends on the physicochemical properties of the water, oil, and gas and the working regime of the unit. The industrial procedure in which water and petroleum were passed through a pump until the properties of the emulsion arriving at its intake and received at the mouth of the well were the same made it possible to make interpretation of experimental results more exact. Elimination of the influence of the gas here was also a unique feature of the studies.

The temperature regime of movement of the fluid under stand conditions corresponded entirely to actual conditions (the temperature gradient in the shaft of the well remained constant). The wells were studied in several regimes. All this made it possible to compare the basic parameters of their work in the same and variable industrial regimes, identify the characteristics of the process under study, and draw certain preliminary conclusions.

Figure 2 below shows the distinctive barograms of pumping out water, oil, and an emulsion containing [illegible] percent water at well No [illegible] and the barogram for pumping out water at well No 31. The viscosity of the emulsion measured with a Reotest-2 viscosity gage in a field laboratory with shift gradients in the interval from 27 to 200 $seconds^{-1}$ was [illegible] poise.

Analysis shows that the minimum pressure point on each curve coincides with the start of rod movement downward and the entire curve corresponds to the full cycle of rod movement. The lower curves resemble the upper ones in shape and are proportional in amplitude to the depth at which the sensors are installed. The shapes of the curves permit the change in pressure during the cycle of pump work to be explained as follows. In the first half-cycle the increase in pressure observed in the middle part of the downward movement of the rods is caused by their friction against the liquid. In the second half-cycle it is

caused by the inertia of the column of liquid set in motion by the plunger of the pump and by the wheel of hydraulic resistance in the pipes. In this case the maximum of the summary curve is shifted closer to the start of rod movement upward.

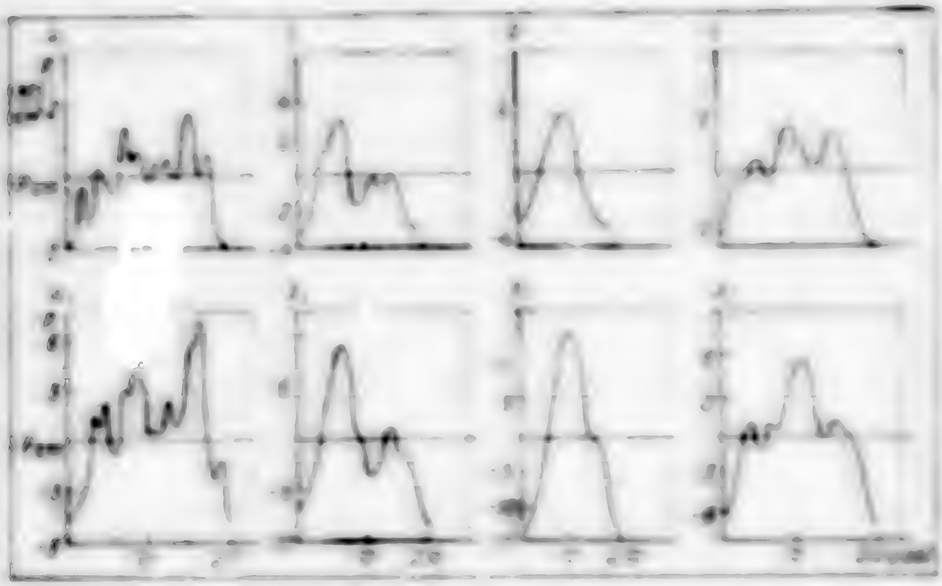


Figure 2. Pumping out barograms (Well No [illegible]): a, a' — water; b, b' — oil; c, c' — emulsion. Well No [illegible]: [illegible] — water. a, b, c, [illegible] — depth of 700 meters, a_1, b_1, c_1, d_1 — depth of 1,000 meters.

The barogram received during the pumping out of water shows a large number of irregular pulsations of pressure. They repeat with each new cycle and result from the combination of pressure fluctuations from elastic deformations of the columns of rods and pipes and from the inertia of the fluid being pumped out and its compressibility. The low viscosity of water inside the pipes makes it possible to call the pressure fluctuation inertial.

A comparison of barograms obtained in a vertical well (see Figure 2, a, a_1) and a slant well (see Figure 2, [illegible]) in identical regimes showed that the amplitude of fluctuations is the same in both cases, but the shapes of the curves differ. The vertical well has more pulsations than the slant well. Semidry friction in the curved shaft markedly reduces the elastic movements of the rod.

Substitution of degassed petroleum for lower water yielded a qualitative change in the shapes of the barogram curve. Two pressure extremes during the working cycle of the installation were clearly marked on the graphs. The increase in viscosity of the fluid caused an increase in pressure in the first phase of pumping out (rod movement downward).

and a certain decrease in the second phase. The frequency of pulsations diminished noticeably here.

The curves shown in Figure [illegible], б, в, which characterize the lifting of a high-viscosity emulsion have only one strongly marked pressure maximum. The forces of hydrodynamic friction predominate in the general balance of forces causing the occurrence of additional pressure. All fluctuations of an inertial type are completely quenched by them and therefore do not affect the shape of the barogram. The disappearance of the pressure extreme in the second half-cycle, upward movement of the rod, is interesting. Despite the existence of significant hydraulic resistances in the pipes, throughout the entire second half-cycle the pressure remains lower than static pressure because the rods, moving upward, draw the fluid behind them, thus creating a kind of "thinning" of static pressure. This phenomenon does not occur in installations with large pump diameters.

From work [1] we know the effect and methodology of calculating the largest diameter of the pump plunger at which pressure no longer drops. The theoretically calculated plunger at which this effect is manifested coincides with the actual size.

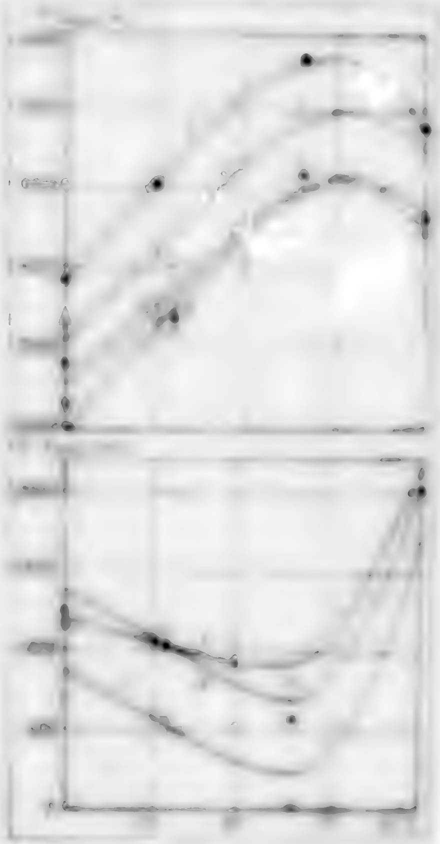
The dynamograms were processed for maximum and minimum loads on the rocker arm. On the average, while the rods are being brought up in a slant well the load exceeds the same load in a vertical well by [illegible] kilogram-force. When the rods are being lowered the load in a vertical well is [illegible] kilogram-force greater than the load in a slant well. The increase in the amplitude of strains in the metal of the rods in a slant well is caused by friction between the rod couplings and the walls of the pipe. The relative error of measurement of forces by the dynamograph was [illegible] percent in the experiment.

Like the curvature of the well shaft, the water content of the oil increases the maximum and reduces the minimum load on the rocker arm.

Figure [illegible] shows the dependence of extreme loads on the water content of the petroleum in a vertical well where the fluid is pumped out at different rates. Constructing the same relationship for a slant well, we observe a complete analogy except that semidry friction is added to viscous friction (see Figure [illegible], curve [illegible]).

The formation of emulsions in wells has a negative effect on pump work, significantly decreasing the delivery coefficient of the installation. By analogy, the greatest decrease here is observed in the area of high emulsion viscosities for all the regimes of pump work studied. The decrease in the delivery coefficient of the installation should be related to the loss of plunger movement as the result of large deformations of the rods and pipes and also hydraulic losses in the valves of the pump.

Figure [illegible]. Dependence of Maximum (a) and Minimum (b) Loads on Rocker Arm on Water Content of Well Output (1 — q = [illegible] l/Min [Well No. [illegible]]; 2, 3, 4 — q = [illegible] l/Min Respectively [Well No. 216]; 5, 6, 7 — q = [illegible] l/Min Respectively [Well No. [illegible]])



A further increase in the water content in the mixture in the water content in the mixture in the pipe led to growth in the delivery coefficient. However, because of lower density and better lubricating properties, the delivery of water-free oil remains somewhat higher than the figure for delivery of water.

The viscosity of oil emulsions drops sharply in the water content interval 75-100 percent [3].

The results of these investigations demand further careful study and processing, but some recommendations for the operation of flooded and [illegible] wells can be given on the basis of this material.

Eliminating or reducing the friction of rod couplings against the pipes will make it possible to improve the operating conditions of the entire pumping unit, giving a corresponding increase in the period of well operation between overhauls [1]. There are ways to protect

installations against the unproductive loads experienced under all actual conditions. For example, shielding the body of the rods with quickly removable plastic cylinders that have a low friction coefficient paired with metal and do not cause large hydraulic resistance owing to the streaming form of motion. Some useful experience has been acquired in the Bashkir ASSR with the operation of such attachments.

A fairly effective means of pumping out highly viscous emulsions has been developed and recommended. Petroleum and gas extraction administrations of "[illegible]" ["Chekmagushevsk" Petroleum and Gas Extraction] are installing pneumatic pressure compensators (closed vessels (chambers) connected in the lower part with the interior of pumping pipes) which are spaced at definite distances apart down the column of pumping pipe.

The compensators smooth out pressure pulsations and reduce the hydrodynamic friction of the rods because while the column is being lowered the fluid frequently escapes from the pipes into the compensators, reducing the velocity of the counter movement of the rods and fluid. It has been shown experimentally that it is most effective to install such devices every 100-300 meters to the depth of the well. Complete or partial elimination of pulsations from the work of the deep sucker-rod pump significantly increases pump delivery and reduces loads in the rod column, which ultimately increases the working life of the equipment. Tests on such units have demonstrated that they can make it possible to increase the delivery coefficient of pumps by 20 percent.

Conclusions:

1. Unfavorable conditions are observed for deep pumps when pumping out highly viscous emulsions, especially at high rates.

2. To eliminate unproductive loads in giant wells and wells that produce viscous emulsions, the use of pneumatic compensators and plastic antifriction cylinders along the column of pumping rods is suggested.

FOOTNOTES

1. "Metodika Opredeleniya Sil Gidrodinamicheskogo Treniya v Obvodnennykh Skvazhinakh" [Methodology for Analyzing the Force of Hydrodynamic Friction in Flooded Wells], Ufa, OMTI, VNIISPTneft', 1977.

2. [illegible], V. I., Lazarev, G. A., and [illegible], M. I., "The Effect of Various Factors on the Viscosity of Water-Oil Emulsions" NTS NEFTEPROMYSLOVOYE DELO, Moscow, VNIIOENG, 1973, No 2, pp [illegible].

7. [illegible], [illegible], "[illegible]" (The Operation of a [illegible] Unit in Different Conditions of [illegible]), Baku, [illegible], [illegible].

11,139
CSO: [illegible]

UDC [illegible]

SURVEY OF CORROSION PROBLEM IN GASLIFT SYSTEM AT UZEN' FIELD

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 1, Jan [illegible] pp [illegible]

[Article by B. T. [illegible], A. P. [illegible], Yu. V. [illegible], Kazakh SSR Scientific Research and Planning Institute of the Petroleum Industry, [illegible], [illegible], Mangyshlakneft', and [illegible], Kazakh Gas Refinery: "Experience with the Gaslift Complex of the Uzen' Field"]

[Text] At the Uzen' deposit where high-paraffin oils and viscous emulsions are extracted with progressive flooding, the natural flow method is inefficient. For this reason a significant share of the producing wells have been switched to mechanized extraction methods. Electrical centrifugal pumps have not found practical application because of the high content of free gas at the face, paraffinization of the pipes, solidification of petroleum in the outgoing lines, and intensive salt deposition. The limited extraction capabilities of deep sucker-rod pumps make it possible to operate wells producing up to [illegible] tons of fluid a day.

The comparatively long period of well operation between overhauls and high extraction capabilities of gaslift made it advantageous to use in wells with relatively large yields. As a result of carrying out technical designs the deposit established a gaslift system that includes a compressor plant with a capacity of [illegible] billion cubic meters of gas a year and a working pressure of [illegible] megapascals as part of the Kazakh Gas Refinery.

In [illegible] the gaslift group comprised [illegible] wells with an average yield of [illegible] tons a day and water content of [illegible] percent, providing roughly [illegible] percent of the petroleum being extracted. Introduction of gaslift exploitation on a broad industrial scale made it possible to conduct depth investigations of a significant number of wells, receive more reliable information on the production of layers, and take timely steps to improve exploitation.

It was important to establish reliable conditions for the operation of gaslift wells, especially during the fall and winter. In turn, this required technological refinement based on the introduction of up-to-date, reliable gaslift equipment.

The Ministry of the Petroleum Industry stepped up the development of gaslift equipment. Gaslift starting valves and modular automated gas distributing batteries that are brought out to cable devices without calling current repair brigades were built. At the same time the questions of improving the reliability of the gas lift complex by introducing high-pressure gaslift systems were formulated and solved.

However, the experience of past years with operation of the gaslift system at the Uzen' field has demonstrated that creating conditions for trouble-free operation of compressor capacities and gas lines is quite important for improving the reliability of the system. Calculations have established that the gas lines of the gaslift system will work satisfactorily when gas containing no more than 0.4 grams of moisture per cubic meter is delivered; control and monitoring equipment worked satisfactorily with a level of 0.05 grams of moisture per cubic meter.

The gaslift system at the Uzen' field was launched in 1969 and construction there was basically completed in 1974-1975. At first it was fed natural gas from the Tenge deposit, containing up to 0.9 grams per cubic meter of highly mineralized moisture. Since 1976 it has received gas from the Kazakh Gas Refinery, containing up to three grams per cubic meter. The high moisture content has greatly complicated the operation of the gas lines; lowering the gas temperature to 15-17 degrees C led to the formation of hydrates. In the winter gas condensate plugs formed and the furnaces and monitoring and measuring instruments stopped working.

To improve the quality of the gas a large set of studies encompassing virtually the entire huge gaslift system at the Uzen' field (with more than 80 control points) was carried out. This made it possible to outline and take technical measures to build additional [illegible], [illegible], separators, and sediment traps in gas lines at low points on the terrain. This improved the working conditions of the gaslift system, but the problem of preparing gas for it remained unsolved.

At first there was no hydrogen sulfide in the petroleum gas of the Uzen' deposit. After the process of flooding the petroleum layers with sea water began in 1969 sulfate-reducing bacteria appeared in the producing horizons. In 1974 the content of hydrogen sulfide in the output of the petroleum wells increased sharply and reached [illegible] grams of gas per cubic meter in 1977.

The output of the gas refinery was determined for gaslift exploitation envisioned using petroleum gases that did not contain hydrogen sulfide compounds. The [illegible] of the refinery and compressor [illegible] construction [illegible]

as the gaslift system consisted [illegible] with a sharp increase in the hydrogen sulfide content in the gas. Operational steps to reduce the hazard resulted in disconnecting the group installations with heightened hydrogen sulfide content from the gas collection system. At the same time bactericides began to be pumped into the layer to suppress the vital activity of the sulfate-reducing bacteria and the decision was made to build a sulfur-decontamination complex at the Kazakh refinery.

Studies showed that the elements most subject to corrosion damage at the Kazakh Gas Refinery were the refrigeration and evaporation systems during the separation of the broad fraction of hydrocarbons [illegible] higher than the gas, and also the separation units (where the rate of corrosion is [illegible] millimeters a year).

The working agent of the gaslift system from the Kazakh refinery is fed at a temperature of [illegible] degrees C along four gas pipelines to the main gaslift collector and then through the gas distribution batteries to the wells. Because the gas has a high hydrogen sulfide content, in the lower part of gas lines in which a gas-liquid mixture consisting of water, condensate, dissolved hydrogen sulfide, and various admixtures usually accumulates and moves, [illegible] occurred, which is characteristic of [illegible] in the [illegible] regime and, in its turn, confirms the appearance of corrosion.

Thus, the urgency of the problem of protecting the gas lines of the gaslift system at the Uzen' field against corrosion is unquestioned. This problem is made more complicated by the fact that the gaslift system is pressurized to a working pressure of [illegible] megapascal. This necessitated studies to evaluate corrosion wear on the gas lines.

The actual thickness of the walls of the pipes was determined by taking measurements at four points of the pipe cross-section throughout the entire gaslift system at the Uzen' field (see figure). The thickness of the walls was determined by an [illegible] thickness gage and a [illegible] thickness gage. In every case it was observed that the actual wall thickness was more than [illegible] percent less than the initial thickness, which testifies to vigorous internal corrosion of the pipe lines.

As a result, the decrease in wall thickness was greatest in [illegible] segments of the lines. In some sectors the [illegible] is [illegible], which leads to [illegible] selective (pitting) destruction of the metal by [illegible] corrosion. The inner layer of [illegible] on the inner surface of the pipe reaches [illegible] millimeters in damaged places. Laboratory tests of samples taken from a trouble sector of the gas line at [illegible] (group No. [illegible]) showed the following. Because the [illegible] of deposits the lower part of the line was severely corroded, the diameter of pits reached [illegible] millimeters, with depths from [illegible] millimeters to [illegible] holes. The rate of corrosion was [illegible] millimeters a year, and the

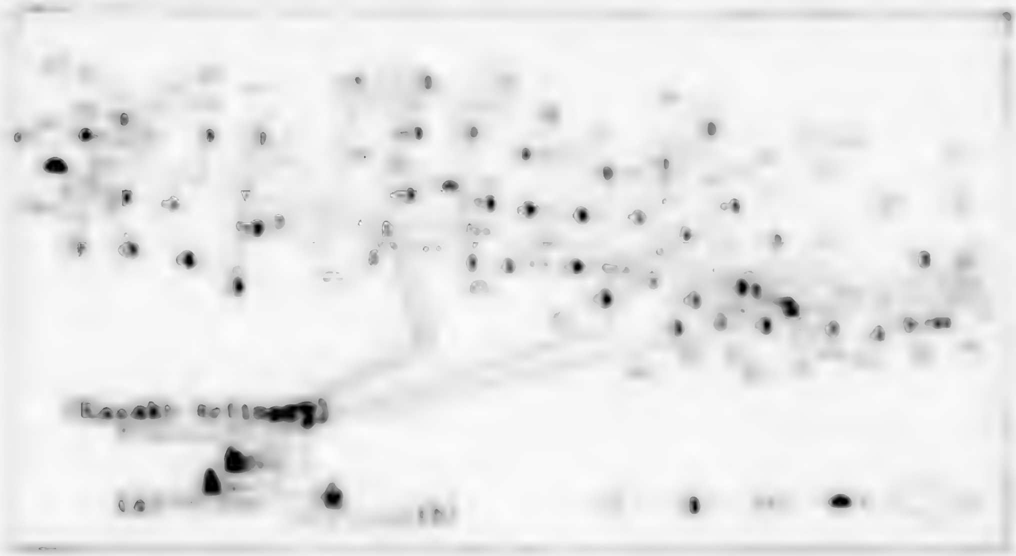


Figure. Diagram of the Gas [illegible] System at the Uren' Petroleum and Gas Extraction Administration and Chart of Corrosion Damage in the Gas Line.

Key: (1) Group Installations;
(2) Group Installations with Gas Distribution Booths;
(3) Regional Installations;
(4) Regional Installation with Gas Distribution Booths;
(5) Zone of Greatest Corrosion Damage (Numerator and Denominator Show Thickness of Wall by Measurements and Documents Respectively);
(6) Uren' Field Gas Control Station;
(7) [illegible] gas collecting point.

actual thickness of the lower part of the pipe was in the range [illegible] millimeters (up to [illegible] percent of the initial thickness). The lateral segments of the line were subjected to uneven, but less intense corrosion. The depth of pits reached [illegible] millimeters with diameters up to [illegible] millimeters. The actual thickness of the wall was [illegible] millimeters and the rate of corrosion was [illegible] millimeters a year. The upper part of the line was subject to slight, even corrosion.

According to State All-Union Standard [illegible] the corrosion resistance of the metal in the lower part of the line is evaluated at eight points on a 10-point scale, which falls in the resistance group "low resistance." The rate of corrosion is evaluated as high. Analysis of metal samples from this part of the gas line following State All-Union Standard [illegible] showed a breaking point of [illegible] kilogram-force per square millimeter upon stretching, which corresponds to the performance

[illegible] gross area. The drop in strength of the gas line metal [illegible] [illegible] is unquestionably evidence that the metal of the pipe has become saturated with hydrogen as [illegible] gas containing hydrogen sulfide is transported long distances through it.

[illegible] corrosion and breaks in gas lines [illegible] [illegible] to stop gas delivery to large segments of the gaslift systems. When [illegible] petroleums are being lifted, later [illegible] of extraction [illegible] [illegible] [illegible] petroleum to the outgoing lines. Moreover, the products of corrosion in a [illegible] of gas lines, [illegible] in the [illegible] measuring and regulating instruments of surface and underground equipment [illegible] by gas heating furnaces, gas distribution batteries, and in wells, disrupts their operation. This requires unexpected ground and [illegible] repair work.

In [illegible] two types of inhibitors were tested to protect [illegible] and field equipment against corrosion. The domestic [illegible] inhibitor was adapted for industrial use. During the testing the rate of corrosion decreased [illegible] times, whereas the imported inhibitor [illegible] produced a decrease of just [illegible] times. Moreover, [illegible] in the process of refining [illegible] gasoline the imported inhibitor facilitated intensified resin formation, which worsened the commodity characteristics of the gasoline.

The [illegible] inhibitor was added to the petroleum gas constantly at a pressure of [illegible] megapascals in the amount of [illegible] grams per 1,000 cubic meters of gas.

At the present time, a unit to remove sulfur compounds and carbon dioxide, with a productivity of [illegible] billion cubic meters of gas a year, is being brought on line. After decontamination the content of hydrogen sulfide and carbon dioxide in the gas will be [illegible] and [illegible] percent by volume respectively. Together with the inhibitor protection this will substantially lower the processes of equipment corrosion.

The gaslift method of well exploitation has high extraction potential and [illegible] [illegible] [illegible] of operations [illegible], which is especially important for stabilizing petroleum extraction in regions with harsh climatic conditions. Therefore, great importance is attached to the gaslift method of petroleum extraction in the sector. However, along with building more reliable ground and underground equipment and [illegible] gaslift systems, a fundamentally new solution should be found, in the design stage, to monitoring and protecting them against corrosion using both technical means and chemical protective methods, on a broad scale. A [illegible] All-Union standard for gas composition for gaslift purposes should be developed in addition to the standard on quality of gas preparation for various climatic zones.

Conclusions:

1. The gas lines of the system are an important element in improving the reliability of gaslift well exploitation.

2. The method of operational monitoring of the technical condition of existing gaslines makes it possible to measure the thickness of walls with a thickness gage and use these data for planned preventive maintenance work.

3. Special preparation of the gases in combination with inhibitors is necessary to reduce the corrosion aggressiveness of the gases used in the gaslift cycle.

4. A State All-Union Standard on gas composition must be developed for different climatic zones to improve the reliability of the gaslift complex.

11,176
CSO: 1822

RULES ANNOUNCED FOR CONTEST ON PROPOSALS TO IMPROVE OIL RECOVERY

Moscow NEFTYANOYE KHOZYAYSTVO in Russian No 1, Jan [illegible] p [illegible]

[Announcement: "Competition for Development and Introduction of Proposals to Increase the Level of Petroleum Extraction from Layers During the Exploitation of Petroleum Deposits"]

[Text] The Central Board of Directors of the Scientific-Technical Society of the Petroleum and Gas Industry imeni Academician [illegible] has announced a competition, to run from 1 July [illegible] to 31 December [illegible], for the development and introduction of effective new methods and broad introduction of existing techniques to increase the level of petroleum extraction from layers.

Scientific research, design, and planning projects introduced into production which have significantly improved the level of petroleum extraction from petroleum deposits are being accepted for consideration.

Proposals being submitted should meet the requirements of improving production efficiency. Their introduction cannot entail violation of the rules for protection of the earth's interior.

Proposals should be submitted in one copy containing a brief statement of the essential features of the project (technical and economic substantiation and calculations with the necessary drawings, diagrams, maps, and photographs attached) performed between 1 January [illegible] and 31 December [illegible] (according to official statistical data). Certification of the economic efficiency of the technique introduced should accompany the materials.

Both individuals and the creative collectives of enterprises and scientific research, planning, design, and other organizations may take part in the competition.

The following prizes are being awarded for the best proposals and most efficient results of introducing methods of influencing a layer: one first prize of [illegible] rubles, five second prizes of [illegible] rubles apiece, [illegible] third prizes of [illegible] rubles apiece.

Materials for the competition may be submitted until 31 December [illegible]. The results of the competition will be tallied in the first quarter of [illegible].

For participants who do not live in Moscow the date of submission of materials is considered to be the postmark date or date shown on the receipt given by the postal division that accepted the package.

All materials submitted for the competition should be in the Russian language under the motto or slogan of the author or collective of authors. The package of materials should contain a sealed envelope with the motto. In the envelope should be a list with the following information about the authors: first, middle, and last name; year of birth; place of work and position; home and work addresses and telephone numbers; membership number for members of scientific-technical societies; information concerning children.

The closed envelopes containing information about the authors are opened only after the results of the competition have been determined and ratified by the Presidium of the Central Board of Directors of the VTO NGP (Scientific-Technical Society of the Petroleum and Gas Industry imeni Academician I. M. Gubkin).

All proposals received for the competition that satisfy its conditions are reviewed by the contest commission (jury) whose membership is ratified by the Presidium of the Central Board of Directors of the VTO NGP. The members of the jury do not participate in the competition and do not consult with respect to materials submitted for the competition.

The prizes awarded to creative collectives of production, scientific research, planning, and other organizations are paid by the Central Board of Directors of the VTO NGP directly to the authors according to a certificate from the organization stating the composition of the creative collective that actually took part in the project. Prizes awarded to creative collectives are paid to the authors in equal shares.

The authors of proposals submitted to the competition do not lose the right to obtain author's certificates for these proposals in the established manner or to receive prizes set up for efficiency experts and inventors.

The Central Board of Directors of the VTO NGP reserves the right to forward for publication proposals received for the competition, including those that do not win prizes. Projects received for the competition (both accepted and rejected) are not returned to the authors.

Materials for the competition should be sent to the following address: [illegible], GSP-1, Moscow, V-296, Leninskiy Prospekt, [illegible], Room [illegible], Central Board of Directors of the VTO NGP. The name of the contest should be written on the outside, but there should be no return address.

[illegible]

CSO: [illegible]

PROGRESS IN FULFILLMENT OF PLANS IN OIL-GAS INDUSTRY REVIEWED

Moscow NEFTYANIK in Russian No 1, Jan 80 pp [illegible]

[Article by V. [illegible], chairman of the Central Committee of the Union of Petroleum and Gas Industry Workers: "Toward New Goals -- Put the Decisions of the 25th CPSU Congress into Practice!"]

[Text] Our country is entering the fifth, final year of the 10th Five-Year Plan in an atmosphere of great political and labor enthusiasm called forth by the decisions of the November 1979 Plenum of the CPSU Central Committee and the second session of the USSR Supreme Soviet. In the past four years the Motherland has progressed significantly in all areas of building communism. Its economic might and international reputation have grown. The efficiency of public production and quality of work are rising steadily, and the production of industrial output and consumer goods has risen significantly.

The CPSU and Soviet government, and General Secretary of the CPSU Central Committee, Chairman of the Presidium of the USSR Supreme Soviet Comrade L. I. Brezhnev personally are devoting substantial and consistent attention to further development of the petroleum and gas industry as the [illegible] and energy sector in Soviet industry. This has predetermined the need for a high rate of increase in petroleum and gas extraction. In the first four years of the [illegible] five-year plan the extraction of petroleum and gas condensate rose [illegible] million tons and gas extraction increased [illegible] percent.

Many production collectives celebrated the second anniversary of the USSR Constitution and the 62nd anniversary of Great October with outstanding achievements in labor. In the first [illegible] months of this year [illegible] billion cubic meters of gas beyond the plan was extracted. The extraction of petroleum, including gas condensate, was up [illegible] percent over the corresponding period of 1978.

About [illegible] brigades in the main occupations of the Ministry of the Petroleum Industry completed their four-year production assignments ahead

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] Association, [illegible] and gas extraction operations [illegible] Petroleum Association, and [illegible] Petroleum Association. The [illegible] of [illegible], from General Secretary of the CPSU Central Committee, Chairman of the Presidium of the USSR Supreme Soviet Comrade [illegible] [illegible] high praise for the labor achievements of the collectives of [illegible] Drilling Administration No. [illegible] and [illegible] Drilling Administration No. [illegible], in particular the drilling brigades headed by [illegible]. The leaders in socialist competition among the Siberian drilling workers consistently produce excellent results in well drilling. For example, on [illegible] drilling brigade became the first well drilling brigade in [illegible] Siberia to fulfill its five-year plan assignment, after which they obligated themselves to complete an additional two years' drilling [illegible] by the end of the year. On [illegible] November foreman [illegible] drilling brigade completed its assignment for the 10th Five-Year Plan [illegible] followed by foreman [illegible] brigade on [illegible] November.

Numerous valuable new initiatives aimed at finding new ways to increase production efficiency and achieve good final results have arisen in the course of socialist competition in our industrial sectors during the 10th Five-Year Plan. These initiatives by working people invariably find support and approval from party and trade union committees and economic managers and are widely disseminated in labor collectives.

In carrying out the decisions of the 25th CPSU Congress to shorten the well construction cycle, the Central Committee of our trade union is doing a great deal to spread socialist competition under the slogan "Build all wells by flow production methods." This competition has enabled trade union committees to involve many collectives of associated workers in the campaign for continuity of work and outstanding quality through the entire well construction cycle. Last year alone more than [illegible] collectives of petroleum workers concluded contracts for this kind of labor cooperation. This movement has developed especially broadly in the [illegible] associations. In [illegible] the plan assignment for [illegible] wells was [illegible] construction was completed on more than [illegible] wells beyond the plan. The construction cycle for [illegible] wells has been shortened [illegible] percent compared to [illegible]. The collective of the [illegible] Drilling Administration of the [illegible] Petroleum Association [illegible] has been especially outstanding in this competition, already by [illegible] reaching the goal for length of well construction for the end of the five-year plan.

This is the result from the patriotic initiative of petroleum workers and the high level of organization of this competition. It is [illegible] that the [illegible] trade union committees [illegible] constant [illegible]

[illegible]

[illegible]

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[illegible] DEVELOPMENTS IN GEORGIAN OIL INDUSTRY

[illegible]

[illegible] general director of the [illegible]

> [illegible] general director of the [illegible] The title of the article was "Georgia: [illegible]" [illegible] the petroleum industry of the [illegible] republic [illegible] general director of the [illegible]

[illegible] August [illegible]

[illegible] In the last [illegible] wells were drilled [illegible] petroleum [illegible] tons of petroleum a day [illegible]

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Moscow NEFTYANIK in Russian No 1, Jan 85 pp 24-26

[Article by V. Abramson, [illegible], [illegible], and [illegible], VNIIBT: "Basic Rules for Using New Bits"]

[Text] The use of bits from the GNU and GAU series does not always produce the expected economic effect because drilling workers often fail to observe the basic rules for using the new bits. These rules have been formulated by VNIIBT (All-Union Scientific Research Institute of Drilling Techniques) on the basis of domestic and foreign experience.

In the current stage of improvement of the technique and procedures for drilling deep and superdeep oil and gas wells, one of the most important problems is improving the technical-economic indexes of the work of the rock-breaking tool. The principal trend in bit making is now to create a large number of type-sizes and designs of bits with heightened strength characteristics which will give a significant increase in drilling per bit when drilling deep and superdeep wells. However, when the new bits are used incorrectly they do not always give the expected economic benefit. This applies primarily to the tricone bits of series GNU and GAU with sealed, oil-filled bearings.

Series GNU bits are designed for rotary drilling and for low-rpm (up to 200-250 rpm) face engines (screw-type and reducer turbodrills) and electric drills. These bits are not recommended for use with conventional turbodrills. Series GAU drills are designed only for rotary drilling.

The design characteristics of series GNU and GAU bits dictate special rules for their operation, but in turn, [illegible] that many drilling brigades do not observe these rules, which sharply reduces the technical-economic efficiency of the bits.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

1. [illegible]

2. [illegible]

3. [illegible]

4. [illegible]

[illegible]

a. [illegible]

an assigned amount of axial load on the bit;

2. [illegible] wrenches with [illegible] (possibly [illegible]) and pneumatic wedges to screw and unscrew the drilling pipe without turning the drilling column by means of the rotor;

3. [illegible] elements (centralizers, calibrators, stabilizers, wideners, [illegible], shock absorbers, and vibration dampers);

4. torque meter and flow gage;

5. a special attachment, a fit insert (bushing) in the rotor, with a configuration strictly corresponding to the configuration of [illegible] and [illegible] bits.

The following requirements must be observed when [illegible] and [illegible] bits are being lowered into the well:

The bit must be screwed onto the lower adapter of the [illegible] only by means of the special insert, which should grasp the bit by the sides of the teeth [illegible] the outlet [illegible] of the [illegible] and the surface of the [illegible] [illegible]. [illegible] it is forbidden to screw [illegible] the rotor is turning or when an insert (bushing) not corresponding to the configuration of the bit is used in the rotor. The bit must be lowered [illegible] smoothly, without blows and jerks. The "[illegible] tightening" should be done by [illegible] wrenches.

The bit must not be allowed to strike the table of the rotor, the bit screwing attachment, or other metal objects.

Before the bit is lowered into the well a check must be made to be sure that the diameters of the [illegible] elements correspond to the diameter of the bit.

To avoid possible damage to the [illegible], [illegible], and [illegible], [illegible], and [illegible] units of [illegible] and [illegible] bits while they are being lowered, the following conditions must be met:

a. In the upper part of the shaft lower the tool following the geological engineering order (the [illegible] [illegible]) without rotating the column of drilling pipes;

b. In the [illegible] part of the [illegible] — well [illegible] with [illegible] of larger diameter than the

[illegible] and [illegible] bits, lower the bit at the rate assigned in the geological engineering order (industrial engine card) without rotating the column of drilling pipes.

3. In a segment of the well shaft corresponding in diameter to the [illegible] or [illegible] bit, around the [illegible] and shoes of casing columns, in narrow places and curves in the shaft, at the points of possible [illegible], in the intervals of crumbling formations, and in the near-face zone lower the tool [illegible], without rotating [illegible] more slowly, carefully, and smoothly, without jerks, [illegible], and with the hydraulic brake fully engaged.

4. When lowering the last [illegible] stands, determine the [illegible] time [illegible] of the weight indicator of the drilling tool.

If the tool becomes stuck while the bit is being lowered into the well, the following steps are necessary: raise the tool, screw on the guide pipe, flush the point above the tool stops, and carefully continue lowering it with the circulation turned on. If flushing the point does not produce satisfactory results, the lithological composition of the rock in this interval must be determined from the geological engineering order or industrial engine card and, if all the rock is [illegible], the sticking point is worked out. In zones which have abrasive rocks the shaft of the well cannot be worked out with [illegible] or [illegible] bits. In such cases, the tool must be raised out of the well, the [illegible] or [illegible] bit replaced with a bit that has an open [illegible] with [illegible] rigging of the [illegible] ring of cutters, and [illegible] the narrowed segment of the shaft worked out with it.

At [illegible] meters from the well bottom the guide pipe must be screwed on and the near-face zone carefully flushed. The bit must be brought into the near-face zone and to the surface of the well face slowly, with flushing and without rotation (for the rotary method of drilling and in a configuration with reducer-type electric drills). When [illegible] bits in a configuration with hydraulic [illegible] engines are being lowered, the near-face zone should be flushed for a longer time, and stopped at [illegible] meters from the surface of the face so that the face can be reached without rotating the bit.

Rotary drilling with [illegible] and [illegible] bits has the following distinctive features.

The crucial moment in the use of these bits is the beginning of their operations. The tool and bit are run in as follows. The bit is brought to the face surface without rotation, and [illegible]. An axial load of the bit is raised to [illegible], depending on the [illegible] of the

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	Roll Number	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]	Bit Number	[illegible]	[illegible] rpm's
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible] it is advisable to drill [illegible] rpm's with reduced axial loads on the bit. [illegible] increase in frequency of rotation [illegible] a greater increase in the mechanical speed of cutting than increasing the axial load. In addition, drilling at increased rpm's [illegible] the possibility of [illegible] on the bit.

In [illegible], it is advisable to drill with greater axial pressure on the bit and reduce rpm's, because an increase in axial [illegible] is more effective in raising cutting speed than increasing rpm's.

In sands and other abrasive rocks and in [illegible] and fragmented rocks it is advisable to reduce the frequency of rotation of the rotor to [illegible] greater wear and destruction of the [illegible], sealing elements of the cutter holders, and the [illegible] of the arms.

The selected combination of drilling [illegible] parameters for the [illegible] and [illegible] bits in a [illegible] rock layer should be held constant. When [illegible] and [illegible] bits with hard-alloy teeth are used a variation of [illegible] percent from the average mechanical speed of cutting [illegible] does not yet indicate a significant change in the properties of the rocks being drilled. Changes in [illegible] mechanical rates of cutting in a broader range may indicate significant [illegible] categories changes in the hardness of the rock being [illegible], after which the necessary corrections will have to be made in the drilling parameters.

When drilling with [illegible] and [illegible] bits uneven rotation and feeding of the bit, sharp braking and sudden stops, [illegible], and [illegible], and a heightened

level of vibration are two primitive reasons that lead to breakage, chipping, and other damage to the hard-alloy teeth and premature wearing out of the working elements and holders in general.

In order to remove drilled rock from the face and near-face zone of the well shaft quickly, prevent clogging of the well with cuttings and cutter formation, to clean the teeth of the cutter so they can be fed into the rock, to transport the crushed material through the well shaft, and thus increase the efficiency and longevity of the bit, it must realize the fluid power necessary to ensure that the drilling solution is discharged from the nozzles at 150-170 meters per second.

When the fluid power delivered to the bit is inadequate, the drilled material is not efficiently removed from the surface of the face and the near-face zone of the well shaft. As a result, an increase in axial pressure on the bit and frequency of its rotation does not yield a marked increase in the mechanical rate of drilling, but rather causes greater wear on the elements of the bits and premature wearing out.

In a configuration with low-rpm face engines, screw engines, and reduction-type electrical drills, turbo drills, and multisectional turbo drills, GNU bits give higher technical-economic indexes of drilling at 150-250 rpm. The rules of operation for these bits using rotary drilling also apply to the use of GNU bits in a configuration with low-rpm face engines taking the following characteristics into account:

a. the engines should be started after the bit reaches the surface of the face and an axial load of 4-10 ton-force (depending on the bit size) has been created;

b. the initial cutting of the surface of the face to a depth of 0.15-0.3 m and the running-in of the bit should be done in 20-30 minutes with the same axial loads on the bit;

c. the axial loads on the bit should be 1-3 ton-force less than those given in the table for rotary drilling, but in all cases the axial loads on bits with hard-alloy teeth should be slightly less than bits with milled teeth;

d. the efficient axial load on the bit should be determined by the maximum mechanical rate of drilling;

e. during the drilling operation the level of vibration must be watched carefully and causes of excessive vibration quickly eliminated by changing the axial load on the bit and/or the frequency of its rotation.

It is unconditional, after the bit is raised from the well, that all [illegible] and [illegible] be examined and measured, like the logging and holders, as well as the [illegible], [illegible], and compensation sections of [illegible] and [illegible] series bits are still in working condition with many levels of [illegible]. These bits must be used over until their working life has been fully realized. The only thing necessary is to be sure that there is lubricating oil in the lubricators and, if necessary, to refill them.

As the studies have shown, [illegible] bits in complete accord with the basic rules of [illegible] drilling, rather bits with [illegible] oil-filled [illegible] for drilling oil and gas wells increases the productivity of series [illegible] and [illegible] bits several times. [illegible] the average longevity of the bits, depending on type-sizes and [illegible] drilling regimes, [illegible] hours for series [illegible] bits and [illegible] hours and more for series [illegible], while series [illegible] bits in configurations with [illegible] engines and [illegible] type electrical and turbine drills have longevity figures of [illegible] hours and more.

[illegible]
CSO: [illegible]

FORMATION OF MATERIAL INCENTIVE FUND AT PETROLEUM ASSOCIATIONS

Moscow NEFTYANIK in Russian No [illegible], Jan [illegible] pp 22-23

[Article by G. Levin, deputy chief of the economic planning administration of the Ministry of the Petroleum Industry: "How Material Incentive Funds Are Formed at Production Associations of the Ministry of the Petroleum Industry"]

[Text] In the past years of the 10th Five-Year Plan economic stimulation funds in the petroleum industry have been formed on the basis of stable norms (deduction rates per ton). Deduction rates per ton to economic stimulation funds will continue to be used in the sector in 1981 and in the coming 11th Five-Year Plan because this system is simple, understandable, and, most importantly, guides the entire collective of the production association to attainment of the final goal: increasing petroleum extraction by every means.

The system is based on the principle of the association's direct material interest not only in keeping petroleum extraction at the previous year's level, but also securing the planned growth in extraction and meeting extraction challenges of the counterplan and supplementary assignments. This is promoted by the fact that the deduction rate per ton differs for each of the above-enumerated sections of the plan. Let us demonstrate this with an example.

For a standard oil region, the system of deduction rates per ton to the material incentive fund in 1980 included the following norms (in kopecks): for maintaining extraction at the previous year's level -- 16.16; for the increase in extraction -- [illegible]; for the counterplan assignment included in the increase -- 5; per one percent decrease in specific labor inputs -- [illegible].

As we can see, the greatest material interest in increasing petroleum extraction is achieved by the fact that the per-ton rate for increasing extraction is double the rate for maintaining the past level. Stimulation for additional extraction under the counterplan, exceeding the

assignment of the five-year plan for the corresponding year, in view of a rate for additional extraction based on the counterplan that is twice as high as the rate for an increase in general. As a result, nine percent of the total material incentive fund was created from just this growth against the counterplan.

Because different associations operate in different conditions, the size of the deduction rate per ton to the material incentive fund is established by the Ministry of the Petroleum Industry differentially for each association, taking account of all its special characteristics. But at the same time the main principle is followed: all associations are given equally intensive plans, and the deduction rate for growth in extraction and increasing extraction under the counterplan rises significantly.

The norm of deductions for reducing specific labor expenditures also has a substantial effect on the formation of the material incentive fund. Eleven percent of the total material incentive fund is formed on the basis of this fund-formation index, calculated by multiplying the rate per ton by the size of the assignment (or actual fulfillment) for reducing specific labor expenditures to the volume of petroleum extraction. This technique of stimulating conservation of human labor operates effectively in every oil region and provides material incentive for an annual decrease in specific labor inputs of 4-6 percent.

Extraction of petroleum on a supplementary plan is a significant source for increasing the size of the material incentive fund. In 1979 a supplementary assignment for petroleum extraction was established for each production association. Because plan assignments for petroleum extraction are highly intensive, the search for additional extraction capabilities through better use of wells and other measures is stimulated at a higher rate per ton (see Table 3, supra). At certain times this made it possible to increase the size of the material incentive fund of a petroleum extraction association by 5-10 percent.

Using the rate per ton norms given above, we will take a hypothetical example to show how the planned and actual size of the material incentive fund are calculated.

Initial Figures

Volume of petroleum extraction according to preceding year's plan, tons	5,000,000
Plan of petroleum extraction for planning year, tons	6,000,000
Planned growth of petroleum extraction, tons	1,000,000
Counterplan, tons	6,100,000
Increase in petroleum extraction by counterplan, tons	100,000

"Supplementary" assignment for petroleum extraction, tons	[illegible]
Actual petroleum extraction in current year, tons	[illegible]
In above figure, extracted against "supplementary" assignments, tons	[illegible]
Assignment to reduce specific labor inputs, %	10
Actual decrease in specific labor inputs, %	11

$$MIF_{pl} = [illegible] = [illegible] \text{ rubles}$$

$$MIF_{a} = [illegible] = [illegible] \text{ rubles},$$

where MIF_{pl} is the planned material incentive fund and MIF_{a} is the material incentive fund actually formed.

The actual size of the material incentive fund in this example exceeded the planned amount by [illegible] percent, including the amount gained by extracting [illegible] tons of petroleum against the supplementary assignment.

A mandatory condition for realization of an incentive fund of this size is fulfillment and overfulfillment of the profit plan for the principal activities of the association and its drilling work. Above-plan profit is the source of the additional size of incentive funds in this case. In the example given above the association must form above-plan profit in the following amount:

$$P_{a} = ([illegible] - [illegible]) \cdot [illegible] = [illegible] \text{ rubles}$$

where P_{a} is above-plan profit and [illegible] is a coefficient that takes into account deductions of the fund for sociocultural measures and housing construction which is created as [illegible] percent of the material incentive fund.

The sectorial system of stimulation exercises an influence toward reducing production costs, obtaining above-plan profit, and thereby increasing production efficiency by necessitating the creation of additional sources for formation of above-plan incentive funds.

Thus, material stimulation of petroleum extraction associations supports the final sectorial task, and the economic accountability interest applies both to achieving an increase in petroleum extraction and to improving production efficiency by reducing labor inputs, cutting

[illegible]

[illegible]

It is precisely with this methodological approach that the effect of change in natural conditions can be largely eliminated.

The first group, the indexes of production and delivery of output, are supplemented by three indexes:

a. average available operating wells;

b. commodity (gross) output in constant wholesale prices;

c. output sold in effective prices.

The index of commodity (gross) output in constant wholesale prices is used to evaluate production in real terms, while the index of output sold in effective prices is used during development of the financial plan and to evaluate fulfillment of obligations for delivery of output to customers.

The index of normative output in the sector will not be used, because it makes no sense in an extracting industry.

The group of qualitative indexes of the work of all elements in the production association includes the following:

a. labor productivity in physical terms — extraction of petroleum and by-product gas per employee;

b. norm for number of industrial production personnel per operating well;

c. norm of wages per operating well;

d. profit by types of activity;

e. production costs to operate one well.

Labor inputs in the petroleum industry are determined by the volume of work to operate the wells. Therefore, the normative index of specific number of employees will be the measure of labor inputs that most fully reflects taking scientific-technical steps to conserve live labor (as well as the necessary volume of work to operate the oil field system). This index will be used to determine the planned need for labor resources and to evaluate enterprise activities.

In the petroleum industry production costs, just like labor inputs, are directly linked to operating oil wells. Therefore, the calculated index of production costs to operate one well will, as one should expect, be very effective in application because it is less tied to the impact of the natural factor than expenditures for the extraction of one ton of petroleum, where the effect of the productivity of the petroleum level is substantial. Associations and economic services of the sector must take the most rigorous steps they can to improve this index. During the 10th Five-Year Plan expenditures to maintain one well rose in several oil regions even after expenditures determined by direct account (deductions for geological exploration, energy expenditures, and depreciation deductions) were taken out of the composition of costs.

The remaining expenditures, which are operating expenditures that vary depending on the level of appreciation of production personnel and the organization of repair, operations, and transportation work, must be monitored constantly by the economic services. Any organizational step that affects the magnitude of production costs should be given careful economic weighing and calculation.

Adding the index of specific production costs to control the planned resource requirement and evaluate association activities in the system

of planned evaluation indexes will serve as the essential prerequisite for the development and implementation of a package of measures to re-duce costs.

Reforming the sector's system of [illegible] indexes and development, with [illegible] in mind, of new methodological principles for sectorial planning is a condition for fulfillment of the resolutions of the [illegible] of the CPSU Central Committee and USSR Council of Ministers.

/[illegible]
CSO: [illegible]

FUEL

INCREASED PRODUCTION VOLUME OF [illegible] EQUIPMENT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian [illegible]

[Article by [illegible], chief of VPO Soyuzneftemash: "The Advantages of a Complex"]

[Text] The VPO [All-Union Production Association] Soyuzneftemash produces approximately [illegible] percent of the oil and gas production equipment in the country. It has increased the production volume [illegible]-fold since the beginning of the five-year plan. Soyuzneftemash consists of [illegible] plants, two institutes and a KB [design office].

It should be said that when the idea of fulfilling the five-year plan within four years was first born, many doubted its reality. After all, we are talking about a large industrial complex rather than about a brigade, shop or plant which must increase production volume by a little more than one-half and almost completely renovate the nomenclature of products produced. The calculations showed that the goal is quite achievable. Careful analysis permitted determination of the shortest paths to it. They included the maximum use of the advantages of an association based on concentration and specialization and improvement of the forms of accounting and management.

Where to begin? The experience of associations already existing in the country suggested consolidation and fusion of low-capacity enterprises with stronger enterprises. One can say that this innovation was no accident. This is true. However, if one takes into account that all plants of the economic complex are located in the same city, this resulted in significant advantages. Thus, three enterprises were given small low-efficient plants as production units. Attachment of the low-capacity Plant [illegible] to the large Plant [illegible] permitted a significant increase in the quality of rotary bits and [illegible] by organization of heat treatment of the parts of these products at the Plant [illegible]. There were free capacities there as well. The use of equipment was improved at the same time and the level of technical preparation of the plant by introduction of parts specialization and concentration of production-technical services was increased.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

BUZACHI OIL PRODUCTION COMPLEX REVIEWED

Moscow IZVESTIYA in Russian [illegible]

[Article by [illegible], Mangyshlak: [illegible]]

[Text] Construction has been completed on the first phase of the oil production complex on the Buzachi Peninsula in the northeastern part of the Caspian Sea.

A tanker was tied up at the oil pouring frame of the port of Shevchenko. The tanker had taken on 5,000 tons of petroleum extracted on the Buzachi Peninsula and delivered along a new pipeline laid by construction workers of the Ministry of Construction of Petroleum and Gas Industry Enterprises under the extremely difficult natural and climatic conditions of Mangyshlakskaya Oblast.

A great labor victory has been won to mark the 110th anniversary of the birth of V. I. Lenin. The petroleum transport system that stretches hundreds of kilometers and includes the main trunk lines from Kalamkas through Karazhanbas and Tauchik to Shevchenko has been built much faster than envisioned by norms.

All the facilities were accepted with ratings of "outstanding."

"The large oil industry enterprises in Buzachi, a constituent part of the Mangyshlak territorial production complex," said deputy minister of construction of petroleum and gas industry enterprises V. Khusnutdinov, "are the sector's most important construction projects in the northern Caspian region. The Mangyshlakneftegazstroy [Mangyshlak Petroleum and Gas Construction], Sredazneftegazmontazh [Central Asian Petroleum and Gas Installation], Sredazneftegazstroy [Central Asian Petroleum and Gas Construction], and Shatlykgazstroy [Shatlyk Gas Construction] trusts have sent their best collectives here. The leaders in competition have achieved high rates of work in laying underground lines and building up the oil fields."

[illegible]

[illegible]

[illegible]

[illegible]

PROBLEMS IN THE KASPMORNEFTEGAZPROM [illegible]

Baku VYSHKA in Russian 13 Jan 85 p 1

[Article: "Important Tasks of the Caspian Petroleum Workers"]

[Text] A meeting of management workers of the All-Union Industrial Association Kaspmorneftegazprom [Caspian Sea Petroleum and Gas Industry Association] and its enterprises was held on 11 January.

USSR Minister of the Gas Industry [illegible] spoke at the meeting. After observing that the country's gas industry is developing at a high pace in conformity with the decisions of the 26th CPSU Congress, he emphasized that one of the principal challenges of the Ministry of the Gas Industry is to develop the petroleum and gas resources of the continental shelf of the USSR. Promising results have been obtained from exploration of offshore formations in various regions of the country.

However, Comrade [illegible] emphasized, the existing situation in the area of development of offshore petroleum and gas deposits cannot be considered satisfactory. An especially alarming situation has developed in the primary offshore subdivision, Kaspmorneftegazprom. The association has not met its assignment for extraction of petroleum and condensate in the first four years of the five-year plan. The main reasons are a serious lag in drilling work and poor labor and production discipline. In recent years the volume of drilling and its effective speed have dropped in the association and time losses from accidents and downtime have risen an average of [illegible] percent. Fifteen wells were shut down for technical reasons. Cases of violation of technological well operation conditions, accidents, and gushers have become more common at enterprises of the association.

The fault for these problems lies with the managers of the association, above all its former chief A. [illegible], who tolerated an unacceptable operations situation and lost his sense of responsibility for the assigned jobs. The style and level of management of

The Kaspmorneftegazprom Association is [illegible] and new, higher [illegible].

After discussing the great and important challenges that faced the petroleum and gas workers of the Caspian, Comrade [illegible] emphasized the most important tasks of the Kaspmorneftegazprom Association today are increasing the scale and rate of drilling, improving technical and organizational [illegible] of association subdivisions, raising labor and production discipline, and rigorously monitoring work progress and quality. We must make more effective use of the modern equipment which is being delivered to offshore fields in adequate amounts. Considerable attention should be devoted to the questions of working and living conditions for petroleum workers. We must steadily improve their housing conditions.

In conclusion, the minister expressed his confidence that the collective of the association will mobilize all its reserves to carry out the decisions of the November 1979 Plenum of the CPSU Central Committee and successfully perform its plan assignments for the last year of the five-year plan by all indexes.

[illegible], chief of the Kaspmorneftegazprom All-Union Industrial Association, spoke, giving his assurance that the Caspian petroleum workers will make every effort to overcome existing shortcomings and offer a worthy contribution to development of the country's fuel and energy system.

Among those attending the meeting were [illegible], Chairman of the Council of Ministers of the Azerbaijan SSR, [illegible], secretary of the Central Committee of the Azerbaijan Communist Party, and [illegible], first deputy Chairman of the Council of Ministers of the Azerbaijan SSR.

[illegible]
CSO: [illegible]

GASIFICATION SCHEME FOR UZBEKISTAN

Tashkent PRAVDA VOSTOKA in Russian 17 Nov 79 p 4

[Article by A. Azizov: "New Developments in the Plan for Gasification of the Republic"]

[Text] On commission from the USSR Ministry of the Gas Industry the Saratov VNIPIgazdobycha [possibly All-Union Scientific Research and Planning Institute of Gas Extraction] institute has drawn up a long-range master plan for development of the gas industry of the Uzbek SSR. The group of authors, headed by deputy chief engineer of the institute [illegible] Tutel'yan, visited Tashkent. Here is what he told our PRAVDA VOSTOKA correspondent:

"It is common knowledge that Uzbekistan is one of the major gas regions of the country. Moreover, we should note that the region's natural gas has a high content of hydrogen sulphide and other chemical elements which are used to obtain ethane fractions, a very essential raw material for the chemical industry. Total gas reserves are calculated at [illegible] trillion cubic meters, and the predicted reserve is more than two trillion cubic meters.

"The new plan is figured for extraction of tens of billions of cubic meters a year, 1.5 times as much as is extracted now, and it was drawn up with the acute need for gas fuel and products in mind. Uzbekistan supplies a significant share of all natural gas extracted in the country.

"The plan envisions the establishment of two gas chemical complexes (gas refineries), construction of 1,500 kilometers of new pipeline and reconstruction of existing lines, building three new compressor plants and rebuilding four existing ones.

"Our Saratov specialists have envisioned a series of underground storage facilities and worked out measures to protect the environment, bodies of water, and land situated along the pipelines.

"According to the new master plan the entire gas sector of the republic is being switched to automated systems. Special equipment repair centers, pipeline [illegible], power transmission lines, and roads will be built to serve the system, as well as housing in Mubarek, Karshi, and other regions (total living space of almost [illegible] square meters). An additional [illegible] persons will be employed in the sector to carry out all the work envisioned by the plan.

"The new plan is the first part of a major project for development of the Uzbek gas industry. The Uzgiprogaz [Uzbek State All-Union Institute for Planning Gas Pipelines and Gas Industry Enterprises] Institute is developing the second phase of gasification."

[illegible]
[illegible]

RATIONAL USE OF SHALE, RELATED SCIENTIFIC RESEARCH EXAMINED

Tallin SOVETSKAYA ESTONIYA in Russian 7 Dec 79 p 3

[Article: "Science and the Shale Industry"]

[Text] A general meeting of the Academy of Sciences Estonian SSR, held on 6 December in Tallin, was devoted to rational use of shale and related scientific research.

Corresponding member of the Academy of Sciences Estonian SSR A. Aarna, chairman of the council on the comprehensive program for utilization of combustible shale, presented a report. He observed that a full complex of enterprises and organizations has been built in the republic concerned with the extraction and processing of shale, scientific research on shales, and use of shales to produce energy. Two large power plants producing 1.6 million kilowatts each are in successful operation and the proportion of shale used in the chemical industry is rising.

As for the study of shale reserves, the speaker said that with the increasing interest world wide in solid fuels, geologists of the republic must make a more precise determination of supplies of leaner combustible shales. Their use poses a number of scientific and industrial problems for scientists. The technique used until now of burning shales in dust form produces the cheapest electricity in the northwestern part of the USSR today, but significant difficulties can be expected because of the increase in mineral impurities in each ton. Therefore, testing the procedure for burning such shales in a boiling layer has great applied significance.

Another important group of studies is related to the use of shale as industrial raw material for shale oil. Scientists have made definite contributions to working out methods of heat treatment of shale. Shale processing by means of a solid heat agent, which is now being introduced at the Estonian State Regional Power Plant, needs improvement because of the low quality of the shale oil and

problems with environmental protection. Units to process fine shale in a boiling layer are also undergoing testing. This technique deserves considerable attention because it makes it possible to use fine shale, an unchanged by-product of extraction which constitutes 70 percent of the volume of material extracted.

In this connection the speaker discussed rational use of the principal natural wealth of the republic. At the present time shale losses during extraction are considerable. The State All-Union Standard requirements for shale quality should be revised. When a fuel with lower calorific value is used (under 2600 kilocalories per ton) it will be possible to increase the extraction of this energy fuel four times. Environmental protection also demands considerable attention.

Continued development of the shale industry will depend decisively on scientific research, which makes it necessary to enlarge the scope of scientific investigations and work out problems more deeply.

An appropriate resolution was adopted.

K. Rebane, president of the Academy of Sciences Estonian SSR, awarded professor's certificates, doctor of science degrees, and medals of the Exhibition of Achievements of the USSR National Economy to a group of scientists.

[illegible] Epik, vice president of the Academy of Sciences Estonian SSR, informed the audience of the primary steps that have been taken to increase the efficiency of academy operations.

Amendments to the charter and other fundamental documents of the Academy of Sciences Estonian SSR were adopted.

Among those participating in the work of the general meeting were V. Valjas, secretary of the Central Committee of the Estonian Communist Party, V. Kotel'nikov, vice president of the Academy of Sciences USSR, and [illegible] Grechkina, division chief of the Central Committee of the Estonian Communist Party.

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BRIEFS

MINE CLIMATE CONTROL--Odessa--The collective of the Odessa Refrigeration Machine Building Production Association has begun series production of mobile "climate machines," which provide cool air to working spaces in coal mines at depths down to 1,200 meters. A large batch of the new automatic cooling units has been shipped to miners in the Donets Basin. Even today dozens of mines in the Donets coal basin are developing coal seams at depths of more than 1,200 meters, where the temperature and humidity of the mine atmosphere rise significantly. The compact mobile cooling units, which operate automatically, will help create working conditions that meet the highest health standards in deep mines (especially those with extensive networks of faces). The enterprise collective has obligated itself to manufacture about 100 automatic "climate machines" for Donets miners in the coming year. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 26 Dec 79 p 2] 11176

NEW WELDING UNIT--Nizhnevartovsk--Viktor Dagin's brigade of administration No 19 of the Samotlortruboprovodstroy [Samotlor Pipeline Construction] Trust has just completed testing the new K-584 electrocontact welding unit. It is designed to make small-diameter piping used in construction at oil fields. The tests showed that the device is 10 times more productive than the most highly skilled welder. The experimental model of the innovation for Samotlor pipeline workers was developed by specialists at the Institute of Electrical Welding imeni Ye. O. Paton. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 26 Dec 79 p 2] 11176

AUTOMATION AT SHATLYK--Ashkhabad--Automation of the primary gas extraction complexes of Turkmenistan has been completed at the Shatlyk field. Operators at control consoles now control all the processes of gas extraction, processing, and transportation. Introduction of the new equipment made it possible to raise the efficiency of work at the fields. Since the beginning of the current five-year plan the natural gas workers have extracted from the Karakum and delivered to the Central Asia -- Central Zone trunk pipeline 97 billion cubic meters of gas more than in the preceding five-year plan. In addition they have almost doubled the extraction of gas condensate. In 1979 alone nine promising new deposits were discovered. [Excerpt] [Moscow IZVESTIYA in Russian 1 Jan 80 p 1] 11176

GIANT MINE OPENS—Karaganda—Just before New Year's Day the collective of Tentekskaya Mine No 3, the largest in the sector, sent up its first tons of coal. The projected capacity of the enterprise thus launched is 4 million tons of coal a year. During construction of the mine by collectives of the general contracting Karagandashakhtostroy [Karaganda Mine Construction] combine, seven vertical and inclined shafts were made with 64 kilometers of excavation, 47,000 cubic meters of reinforced concrete were installed, and 126 kilometers of pipelines were built. The mine now has all necessary conditions for highly productive work. The long walls are equipped with up-to-date KM-87E, OKP-1, and MK-75 complexes and powerful conveyors. An automated control system and loudspeaker communication will help miners solve production problems on an operational basis. In the first days of the new year the miners did very well. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 3 Jan 80 p 1] 11176

HEAT LINE EFFICIENCY—Donetsk—Scientists at Donetsk University has found an effective way to reduce heat losses en route from the central heat and electric power plant to the customers. They have proposed adding surface-active substances to the heated water. These additives "pacify" the turbulent streams that occur when a fluid moves. This not only reduces heat expenditure during transportation, but also increases pipe resistance to corrosion. The additive forms a protective film on the walls of the pipe. "The heat-saving technique developed in Donetsk offers new opportunities to develop centralized heat supply systems," said corresponding member of the Academy of Sciences Ukrainian SSR I. Povkh. "The heightened requirement for clean air in the basin made it necessary to move heat and electric power plants outside of the cities. This makes the trunk lines longer and requires larger pumps and pipe. The method we have proposed makes it possible to solve this problem at significantly lower costs." The scientists' innovation has already been successfully tested in Donetsk. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 4 Jan 80 p 1] 11176

NORTHERN GAS PIPELINE—Ukhta—The system managed by the Ukhtatransgaz [Ukhta Gas Transportation] Association stretches for hundreds of kilometers. This collective is delivering gas to the central zones of the country along the multipipe Northern Lights pipeline. The Northern Lights line is building up its capacity. Collectives of construction workers from the Ministry of Construction of Petroleum and Gas Industry Enterprises recently began construction of its fourth phase. The first kilometers of 1,420-millimeter pipe have already been welded. When the new phase is launched in 1980 the trunk line will be one of the largest in the country in terms of productivity. About 90 billion cubic meters of gas a year will be moved along it. The greetings by Leonid Il'ich Brezhnev to the country's gas workers

called forth a new surge of labor enthusiasm among republic workers engaged in the extraction, processing, and transportation of Komi gas. They have taken on new, stepped-up obligations in honor of the Lenin anniversary. [Text] [Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 6 Jan 80 p 1] 11176

SURGUT -- POLOTSK PIPELINE--Izhevsk--An important link in the trunk petroleum pipeline from Surgut to Polotsk has been completed with the connection of the Perm' and Syumsi pumping plants. The completion of line welding work in the Udmurt ASSR was a collective contribution by pipeline builders of Glavyuzhtruboprovodstroy [possibly Main Administration for Pipeline Construction in Southern Regions] and associated construction organizations. [Text] [Moscow SEL'SKAYA ZHIZN' in Russian 18 Jan 80 p 1] 11176

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